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Proceedings of the Thirty-eighth Annual Meeting of the American Association of Economic Entomologists (*Continued*)

Friday Afternoon Session, January 1, 1926

The meeting was called to order at 1:45 p. m. by Mr. R. L. Webster, Fourth Vice-President.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The first paper this afternoon is by A. A. Granovsky.

THE EFFICIENCY OF SAWDUST BAIT IN THE CONTROL OF GRASSHOPPERS[1]

By A. A. GRANOVSKY, *University of Wisconsin*

ABSTRACT

The content of this paper is a brief summary of the practical application of the sawdust bait in the control of grasshoppers. The results of the campaign carried on last year in four cooperative townships are better observed this year as contrasted with the infestation in neighboring townships. The adjacent areas apparently received the benefit of increased parasitism.

The sawdust sodium arsenite bait gave excellent control of the pest under different ecological conditions in two widely separated sections of the state, infested with different species of grasshoppers. The use of molasses is not essential. The large area poisoned with the sawdust bait without molasses gave equally good results.

The chemical analysis of poisoned grasshoppers indicates the presence of a relatively small amount of arsenic for effective poisoning of the pest.

In spite of the very prolonged dry season, the yield of crops this year was invariably higher in all areas participating in the grasshopper campaign.

Grasshopper outbreaks in the northern half of Door County, Wisconsin were looked upon as a necessary evil. Since the time of settlement of the country and deforestation of large areas of land, unfit for intensive agricultural utilization, grasshoppers were breeding undisturbed to a unbelievably large population for years. They found the

[1]Contribution from the Department of Economic Entomology, Wisconsin Agricultural Experiment Station.

conditions ideal for their rapid multiplication. The ecological complex was changed in their favor. With the increase of the breeding grounds, with a suitable vegetation, the grasshoppers became the endemic pest. As a consequence the loss in crops was enormous.

To ameliorate the existing conditions, a campaign against grasshoppers was undertaken on a large scale in the summer of 1924. The plans of the organized campaign called for two, and if necessary, for three successive annual applications of the poisoned bait over all of the breeding grounds just prior to migration of the pest to cultivated areas. The intention was to reduce the grasshoppers to a negligible number over the entire area of the northern half of Door County. With the aid of the parasites and other factors of biological control, it was hoped to reduce them permanently or at least to diminish their number for a considerable length of time.

Four townships and several incorporated villages participated in the campaign of 1924, covering over 25,000 acres of breeding grounds. The formula used was quite different from those usually recommended. Before its application on large areas however, it was given an extensive trial on several farms under local condition. The ingrediences of the formula were as follows:

Sawdust	100 lbs.
Sodium Arsenite	1 qt.
Molasses, black strap	1 gal.
Salt	5 lbs.
Water	7–10 gals.

It was applied at the rate of 10–20 lbs. of wet bait to an acre, depending on the grasshopper population. Its cost was negligible, amounting only to about 8 cents per acre. The results of the work exceeded our expectation in less than one week after application of the bait. The crops of 1924 were not only saved, but the hoppers were reduced to a very few individuals. The field tests and counts showed that the efficiency of the sawdust bait was about 90 per cent killed or even better. However, it was too early to estimate the permanent value of the campaign.

When spring of 1925 came, four townships, two incorporated villages and the Peninsula State Park were well prepared for the second successive annual campaign. The Washington Island was the fifth township to join the campaign for the first time. All preliminary meetings revealed the splendid spirit existing among the farmers toward the campaign. This was considered as a very important sign, for if the farmers were so willing to back the campaign for the second year in

succession, it shows that they had been taught a lesson by the experience of the last year's campaign, and were satisfied with its results. The value of the cooperative community campaign against a common foe was in evidence.

Although grasshoppers were not expected to be serious in the areas well poisoned the year of 1924, the growers were ready to poison all of the breeding grounds again. It was assumed that if the hoppers would be subdued artificially by poisoned bait to a small number, the rest of them would be kept in control by parasites, diseases and other natural factors. To accomplish this end, the second poisoning seemed necessary.

The typical breeding grounds were carefully watched for the hatching of the pest. The hatching this year began about May 27, nearly two weeks earlier as compared with that of 1924. The majority of them were out by the middle of June. Every one was expecting more hoppers than actually could be found. The thickest grasshopper population was found to be only three or four to a square yard, usually, however, only one or two to a square rod on all of the area, which was well poisoned last year. It was almost unbelievable, especially if we take into consideration the fact that in 1924 they numbered in places more than 200 to the square foot. The results of counts of newly hatched pests showed better than ever before, that the sawdust sodium arsenite bait gave unusually good results. This was even more evident, when the treated areas were contrasted with the infestation in the neighboring townships, such as Washington Island and Jacksonport, where grasshoppers were quite abundant. The same can be said of the places that evidently were missed or poorly poisoned last year. According to information collected, there were fewer grasshoppers observed in the northern half of Door County this year, than at any time within the memory of old settlers. The second annual poisoning was unnecessary. This is attributed to the efficiency of sawdust bait. Only in a few places, evidently missed last year, a slight application of bait was resorted to on very limited areas in Egg Harbor township.

In town of Jacksonport, however, which did not participate in the campaign last year, several progressive farmers individually resorted to hand mixing of poisoned bait to control the hoppers on their land. While Washington Island township decided to carry on the cooperative campaign, because many fields were quite heavily infested. Standard sweeping tests revealed the presence from a few to nearly one hundred of grasshoppers to a square foot. In most of the places there were about 30–50 grasshoppers to a square foot.

The Washington Island campaign was started on June 26 and finished late in the afternoon of July 1, 1925. In general, the plan tried out last year, which proved to be successful, was followed by the Washington Island people only with a few minor modifications to improve the efficiency of the work.

On account of the experience acquired in the campaign conducted in four cooperative townships in 1924, all phases of work were much improved, which resulted, not only in the greater efficiency of the work, but also in the economy of time, labor and money. The poisoned bait was scattered among the sheep, cattle and horses under all conditions on farms, without a single case of animal poisoning.

During the campaign on Washington Island nearly 6,000 acres of grasshopper breeding grounds were covered at a cost of a little more than 6 cents per acre. This insignificant amount includes the wages of the mixing crew and district leaders, as well as the cost of the material and the construction of the bait mixer. The campaign resulted in a thorough control of grasshoppers.

It may not be amiss to give a tabulation of the expenses incurred in controlling the pest on well defined unit such as Washington Island presents.

Cost of mixer	$56.42
Cost of poison (Sodium Arsenite)	74.00
Molasses, 3 barrels	53.40
Salt, minor equipment, etc.	51.82
District leaders' wages	48.00
Mixing crew wages	80.50
Total cost	$364.14
Money appropriated for campaign	400.00
Money left	$35.86

The tabulation shows clearly how cheaply grasshoppers can be controlled by the community efforts, providing the bait is scattered by volunteer labor, given by all farmers in form of one or two days of work for the common good. The time spent in spreading the bait is well repaid in profits from crops saved from destruction.

When a comparative study of infestation was made on treated and untreated areas, it was found, as it was expected, that the untreated breeding grounds, adjacent to the treated areas, received the benefit of increased parasitism. The bee-fly, *Systoechus vulgaris* was very abundant in the untreated areas. The same can be said of tachinid and sarcophagid flies, as well as of ground and blister beetles. While the

grasshoppers on treated areas were literally covered with the red mites, *Trombidium* sp. Many grasshoppers were so badly infested with mites, that they lost their wings due to severe injury. It was also observed that about 65 per cent of females and about 57 per cent of males were infested with the very common and efficient nematode, *Mermis nigrescens*. The intensity of infestation varied between one and eight nematodes per hopper. It is hoped that the work of parasites will keep the pest in check for many years.

The sawdust sodium arsenite bait was found to be efficient not only in the control of clear-winged locust, *Camnula pellucida* (Scud.), which is the most abundant species in the peninsular region, but it proved to be equally efficient in the control of other species, such as *Melanoplus atlanis* (Riley), *M. luridus* (Dodge), *M. femur-rubrum* De Geer, *M. bivittatus* Scud., *Dissosteria carolina* Linn. and *Chortophaga viridifasciata* De Geer. All of these species are common in the peninsular region, and are listed in the order of economic importance.

While the northern half of the peninsula and Washington Island succeeded and kept grasshoppers in excellent control by using the sawdust bait, other sections of the State were in places seriously threatened by grasshoppers. This especially was the case in the southern part of the state, known for its extensive tobacco growing industry, where many of the tobacco fields suffered quite heavily from grasshoppers. A typical injury consisted of riddling the tobacco leaves, and in severe cases stripping them completely, leaving only midribs and a few lateral veins. This, of course, not only reduced the market quality of crop, rendering it unfit for high priced wrapping tobacco, but also involved a considerable economic loss.

The species in greatest abundance in the tobacco growing region proved to be our common red-legged meadow grasshopper, *Melanoplus femur-rubrum* De Geer. Its breeding grounds, as a rule, have been located in the old sod, such as natural meadows, clover and alfalfa fields, but the more favored places were found to be in the old timothy sod. Practically every tobacco field, bordering with sod or pastures suffered considerable loss from grasshopper ravages. The plants along the edges of the fields were completely stripped.

In order to relieve the threatening situation, fourteen demonstrations of grasshopper control were given during the month of August, using the sawdust bait formula. It is of interest to note that this bait proved to be just as effective in controlling the pest in two widely separated sections of the state, under entirely different ecological conditions.

Upon detail inquiry into grasshopper situation in the southern part of the state, it was found that the hoppers had been increasing in number for at least 5 to 7 years. The rainy summer season of last year, evidently did not check the progressive increase in their number. The same can be said of Washington Island, which was quite heavily infested with grasshoppers as compared with the main peninsula, although their climatic conditions are nearly the same. The difference in infestation must be attributed to the efficiency of the sawdust sodium arsenite bait.

During the progress of campaign many points of research nature were considered. The most outstanding, however, was that of producing the cheapest possible bait without lowering its efficiency.

In the last two years the bait was applied on breeding grounds before and not after the migration of the pest. The sawdust was substituted for bran and amyl acetate was eliminated as an attractant. Two tests tried in 1924 indicated that molasses probably could be eliminated. Several tests conducted during the early summer of 1925 showed that molasses is not essential and can be entirely omitted, which reduces the price of the bait to 5 or 6 cents per acre. In treating a large acreage, a considerable saving can be effected by omitting this ingredient.

More than half of the total acreage on Washington Island was poisoned with the bait without molasses, giving over 90 per cent efficiency, and no appreciable difference in efficiency could be noted when compared with the bait containing molasses.

Two other points of interest may be mentioned. In all literature on grasshopper control we always find recommendations to put on the bait while fresh. The experiments conducted last and this year, definitely proved, that old fermented bait is of greater value than fresh. This statement is also supported by the observations made during the campaign on large acreage. It stands to reason, for the poison in solution penetrates the particles of sawdust on standing and cannot be easily washed out or leached. Not only a few days old bait was used in these experiments, but weeks old and even one year old bait, when moistened with a little water, proved to be very effective.

The other point is that of time of application. Standard recommendations are to scatter the bait early in the morning. This is a fairly good recommendation for a small acreage, providing the bait is not put out too early, especially on cold mornings. It is a well known fact that grasshoppers are feeding at temperatures between 70 and 80° F. Our observations indicate that the greatest feeding is done between 11:00

a. m. and 1:00 p. m. The best time for the application of bait is consequently about 10:00 a. m. just before their greatest feeding activities. In any extensive campaign it is impossible to comply with this measure. Bait was spread from early morning to twilight in the evening with apparently good results. Heavy dew or a small shower makes the old bait attractive again, as long as it remains within the reach of the hungry pest.

It is of interest to note that the living grasshoppers are devouring their poisoned dead, and in turn die from consuming a sufficient amount of arsenic to cause their death.

In order to determine the approximate lethal dose of arsenic needed to cause grasshopper's death, several preliminary chemical analysis of poisoned grasshoppers have been made. The modified Gutzeit test for determination of small amounts of arsenic was employed. It was found that slightly more than one micro-milligram of arsenic, determined in arsene form, is needed to cause the death of one adult red-legged grasshopper.

The living grasshoppers collected in the field one week after the application of bait also show faint traces of arsenic present.

In conclusion it may be mentioned that the survey conducted this fall among the farmers in Door County shows that the yield in crops in 1925 was invariably higher in all areas participating in the grasshopper campaign, as compared with the yields of a few previous years. This was the case in spite of the very prolonged dry season during the growing months of the year. No doubt, this is due to reduction in grasshopper population. In the past years they usually destroyed the foliage or reduced the leaf surface of the plants. This diminished the photosynthetic activities of plants, resulting in a scant growth and inferior market quality of grains and forage crops. This year foliage was untouched by the pest which resulted in greater yields of crops.

The process and the results of the campaign have been observed by several entomologists. In this connection I wish to express my gratitude to Dr. S. B. Fracker, State Entomologist and Mr. E. G. Bailey, Door County agricultural agent, for their keen interest in this project, constructive criticism and kind assistance in the work.

MR. R. C. SMITH: I should like to ask if the speaker observed any difference between the different kinds of sawdust, whether fresh sawdust was any more attractive or unattractive than older sawdust.

MR. A. A. GRANOVSKY: We used all sorts of sawdust. However, we always try to get one or two year old sawdust. We do not like to use sawdust that is partly disintegrated.

MR. J. J. DAVIS: I might say that in our experiments in using sawdust in Indiana during the war some years ago we found that the sawdust from Coniferous trees had rather a decided repellent action, and as Mr. Granovsky has stated, the older sawdust gave the best results.

FOURTH VICE-PRESIDENT R. L. WEBSTER: We will now pass to a paper by H. C. Severin.

THE COMMON BLACK FIELD CRICKET, *GRYLLUS ASSIMILIS* (FAB.) AND ITS CONTROL

By H. C. SEVERIN, *South Dakota State College, Brookings, S. Dak.*

ABSTRACT

This paper is the result of 12 years of study of the common black field cricket, *Gryllus assimilis* (Fab.), in South Dakota. In this paper the economic importance of the cricket is discussed, and this is followed by an account of the distribution of the pest over South Dakota. The systematic status of the insect is treated, and then follows a discussion of the life history. The paper is concluded with an account of the relative importance of the parasitic and predaceous enemies of the cricket and finally with a discussion of control measures.

ECONOMIC IMPORTANCE

The black field cricket, *Gryllus assimilis* (Fab.), is an insect pest of major importance in South Dakota. The injury done is caused entirely by the feeding habits of the insect, the greatest amount of damage being done by the later nymphal stages and the adults.

A large variety of vegetable food is eaten by the crickets, but this may be supplemented by animal food whenever such is available. While the crickets may eat any and all parts of certain plants, including roots, stems, leaves, flowers and seeds, a marked preference is shown for the flowers and for the developing seeds. However, when the seeds are hard and mature, they are no longer desired as food. Of all the cultivated plants injured by crickets, alfalfa suffers the greatest harm. It is not an uncommon experience for a farmer to have his entire alfalfa seed crop destroyed in 7 to 10 days thru crickets. The insects will also feed upon the developing seed of wheat, oat, barley, rye, emmer,

flax, sweet clover and corn plants. The injury may be continued upon the small grain crops even tho they be cut and shocked.

Frequently the crickets cut off the seed of the small grain crops and drop it on the ground instead of devouring it. This may be done to the uncut grain or it may be done after the grain has been cut and shocked. The fruits of tomato plants, cantaloupe, watermelon, squash, pumpkin, cucumber, pea, bean and strawberry also serve as food to crickets. The roots of beets and carrots may be attacked as may also the tubers of potatoes.

The flowers and seeds of many weeds are also eaten by crickets, the most important of these being the following:

Russian thistle, *Salsola kali tenuifolia* Meyer
Green foxtail, *Setaria viridis* (L.)
Yellow foxtail, *Setaria glauca* (L.)
Giant ragweed, *Ambrosia trifida* L.
Little ragweed, *Ambrosia artemisiifolia* L.
Rough pigweed, *Amaranthus retroflexus* L.
Tumbling pigweed, *Amaranthus graecizans* L.
Lambs quarter, *Chenopodium album*, L.

While it is true that crickets do not usually have the opportunity of feeding upon the flesh, viscera, etc., of mammals, birds, reptiles and amphibians, they will do so whenever they have the opportunity. Members of the insect world are included in their diet much more often and, consequently, it is a very common occurrence to see crickets feeding upon a dead or weakened fellow cricket, grasshopper, fly, cutworm, etc.

Frequently crickets feed upon and utterly ruin materials made of paper or cloth. Cotton, linen, woolen or silk cloth, all may be attacked, as may also furs. Clothing or articles made of paper seem to be more subject to injury if they are stained with greasy food, milk, syrup or similar materials. Clothing permeated with perspiration seems to be especially relished as an article in their menu. In other words, the field cricket, whenever it invades the home, may become a serious pest therein.

The field cricket has also been accused of cutting binder twine. The writer has not been able to get them to work upon the twine under cage conditions.

Distribution over South Dakota

The insect under discussion is distributed generally over South Dakota. It occurs in our lowest altitudes (979 to 1500 feet above sea level) as well as on the sides and tops of the mountains of the Black Hills

(3200 to 7236 feet above sea level). It is found in the most humid sections of the state as well as in the driest portions. It occurs in the Sand Hills, in the Badlands, on the plains of the central and western portions of the state and on the prairies of the east. Strange to say, the species is found in its greatest numbers on the dry plains and especially on those areas of the plains that are being devoted to the growing of alfalfa, either under a system of dryland farming or under irrigation. It is in these sections also where the largest amount of damage is being done. Here it is not unusual to find from 50 to 200 crickets in a square yard of ground about hay-stacks, but thruout a badly infested alfalfa field their numbers usually do not run over 50 per square yard.

Systematic Status

Gryllus assimilis (Fab.) is the most variable of all our North American Orthoptera. Consequently it is not surprising to learn that it may be found described in literature under many different specific names. Rehn and Hebard[1] list 45 synonyms of this insect. After a thoro study of 1504 specimens of this insect taken from numerous areas in North and South America, they conclude that "in general certain types do predominate over certain regions. These constitute the basis of many of the supposed species, but in our opinion should be characterized by symbols rather than by varietal names, owing to their complexity and the evident fact that none of these are distinct either specifically or as geographic races and really show only the various phases resultant from varied environmental conditions. Should varietal names be used without qualification for such units, even for convenience, the frequent and varied combination of features already proven worthless for either specific or geographical distinction, would preclude the possibility of proper use of even such names of minor importance for many specimens in every large series studied."

Blatchley[2] retains six trinomial names for six "forms" of Gryllus with the suggestion that "students may use them as such and call them variants, varieties or forms of *assimilis* or discard them altogether and lump them as native field crickets under the name of *Gryllus assimilis*."

The writer agrees in the main with the conclusions of Rehn and Hebard regarding the systematic status of the black field cricket, but he believes that there may be two biologic races in South Dakota, one that hiber-

[1]Rehn, James A. G. and Hebard, Morgan. The Genus Gryllus (Orthoptera) as found in America. Proc. Acad. Nat. Sci. of Phil., pp. 293–322, 1915.

[2]Blatchley, W. S. Orthoptera of Northeastern America. Nature Pub. Co. Indianapolis. p. 696–709, 1920.

nates in the egg state, the other as nymphs of usually the fifth and sixth instars.

Life History

Only one generation of the black field cricket is produced during a year in South Dakota. The vast majority of these crickets hibernate in the egg state, but a small per cent, probably less than five, pass the winter as nymphs of usually the fifth and sixth instars. Under normal conditions the crickets that hibernate in the egg stage begin to appear as adults during the fourth week in July and the first week in August. Within two or three weeks practically all of the remainder of the crickets have become adult. Many of these adult crickets have lived out their normal span of life by September fifteenth and have reproduced and died, others, however, live until a heavy freeze destroys them. The crickets that pass the winter as nymphs usually become adult during the latter part of May and during June, reproduce, and die during July. Thus it is seen that there is very little overlapping of living adults of these two biologic races.

Since it is the race that hibernates in the egg stage that is of the greatest economic importance, further discussion of the life history, as well as discussion of the habits and control of these crickets will be limited to this race.

Oviposition

Egg-laying usually begins within two weeks after the female crickets have taken on their adult form and is continued off and on sometimes for two months or longer until death intervenes. Firm soil is preferred for oviposition purposes, but the ground must be soft enough to permit the ovipositor to enter readily. Soils filled with grass roots are not desirable nor is loose ground. In alfalfa fields, the bare ground between plants, the bare edges around ant hills, the bare borders of the fields, the tops and sides of irrigation ditches, and other similar areas are attractive for egg-laying purposes.

Through the ovipositor the eggs are deposited in the soil at depths varying from one-quarter of an inch to slightly more than an inch beneath the surface. Each time an egg is laid, the ovipositor is worked into the soil as far as it can conveniently be driven and then an egg passes thru its valves and out thru the tip. The depth to which the ovipositor penetrates varies with conditions too numerous to mention here. After an egg has been deposited, the ovipositor may be withdrawn from the ground completely or it may be only partially withdrawn, and then usually it is pushed in again and another egg is laid. Oviposition may be

continued in this manner for some little time in one particular area, and as a consequence fifty or more eggs may be laid in an area measuring not larger than two square inches over its surface. Thus it is seen that the crickets lay their eggs in the soil not in masses bound together by a secretion as do the grasshoppers, but singly, and that no special secretion protects the eggs.

Number of Eggs Laid

The number of eggs that are laid by a cricket varies considerably, the usual number deposited ranging from 150 to 400. In a few of our cage experiments only one or two eggs were laid by a cricket and at the other extreme a few of the insects laid as high as 440 to 448 eggs. An average of 10 normal ovipositions gave us 271 eggs per insect. Thru dissections, it was learned that not a single cricket had emptied its ovarian tubules of all of its eggs before it died, for we always found from one to many well developed eggs and in addition numerous small eggs in the ovaries.

The Eggs

Eggs that have been recently laid are elongate oval in form and slightly curved. They are a light honey-yellow in color and measure 0.7 mm. in diameter and 2.8 to 3.2 mm. in length. These same eggs, after passing thru the winter, are cream-colored and they are now less curved but slightly larger. As the embryo develops, the eggs become still larger, while their form, tho quite variable, is usually barrel-like with the ends rounded.

A week or two before the nymphs are ready to leave the eggs, two pinkish eye spots make their appearance at the anterior pole of the eggs and two salmon-colored streaks, the cerci of the cricket, appear at the opposite end. Later, both eyes and cerci become darker and now the head, thorax and abdomen of the nymphs become visible thru the egg chorions. Gradually the nymphs take on the color that they will have when they emerge from the eggs and finally the antennae and legs become visible. The young crickets are now ready to make their way out of the egg shells.

Hatching

The date when hatching begins depends upon the weather. In normal years hatching starts during the last week of May and continues for two to four weeks. In a late spring the time of hatching is delayed, while during an early spring it begins correspondingly earlier. During the spring of 1924 hatching did not begin until June 13 at Brookings, while during the preceding five years it began during the latter part of

May. Not only does temperature affect the time of hatching, but rainfall does also.

The nymphs, before they emerge from the egg shell, break off completely, or in part, a small circular area of the egg shell at the anterior pole. In addition to this, a rent is made in the chorion along the median ventral line of the shell. This rent extends from the circular opening mentioned to a point at or near the middle of the egg. Thru the opening thus made in the egg shell, the nymph enswathed in its vitelline membrane, escapes from the shell.

Each nymph remains enswathed in its vitelline membrane until it has made its way to the surface of the ground. The insect now works its head and thorax above the ground and while the abdomen remains in the soil the vitelline membrane is shed.

Nymphal Instars

A young cricket is able to walk, run and jump immediately after it sheds its vitelline membrane, but it does not acquire the permanent coloration characteristic of a nymph of the first instar until five or six hours have elapsed. A description of each nymphal instar is not included in this paper, but such descriptions will appear in a publication to be issued soon.

Thru cage experiments it was determined that this species of cricket passes thru 8, 9 or 10 nymphal instars before it becomes adult. Since the nymphs devour their molted skins shortly after they shed them, it was found desirable to mark each specimen with a white ink in order to determine with certainty just when a molt took place. Fifty-one male and fifty-four female crickets were reared from the egg stage to maturity in cage experiments. But one of these crickets was confined in each cage and thus the number of instars as well as the duration of these were determined.

The following table shows the number of instars that each male and female cricket passed thru in our rearing experiments:

Number of instars	8	9	10
Male crickets	29	21	1
Female crickets	13	41	0

In the writer's opinion the male cricket which molted 10 times was abnormal, for it required a much longer time to become adult than did the remainder of the crickets. The results of this experiment indicate that the females have a tendency to pass thru one more nymphal instar than do the males.

The duration of the individual nymphal instars varies considerably

and it is undoubtedly dependent upon many conditions, some of which are temperature, food, moisture and parasites. Two normal males that passed thru 8 and 9 instars respectively, required a total of 82 and 93 days to become adult, while two normal females required 83 and 92 days. Thus it is seen that there is no appreciable difference in the duration of the nymphal life of the male and female crickets. However, since the female crickets show a greater tendency to require 9 nymphal instars instead of 8, the females tend to become adult later in the season than do the males.

Natural Enemies

Gryllus assimilis (Fab.) has a host of parasitic and predaceous enemies, the most common being the following:

Ceratoteleia marlatti Ashmead, an hymenopterous parasite of the eggs.

Paradris brevipennis Fouts, an hymenopterous parasite of the eggs.

Exoristoides johnsoni Coq., a tachinid parasite of the nymphs and adults.

Sarcophaga kelleyi Ald., a tachinid parasite of the nymphs and adults.

Cephalobium microbivorum Cobb, a nema parasite of the intestine of the nymphs and adults.

Paragordius varius (Leidy), a thread- or hair-worm parasite of the nymphs and adults.

Gregarina (sp. ?) a protozoan, parasitic chiefly in the alimentary canal of the nymphs and adults.

Euthrombidium (sp. ?) a mite parasitic upon the adults.

Gamasidae (sp. ?) another mite parasitic upon the adults.

Chlorion cyaneum Dahlborn, a predaceous wasp which uses the nymphs and adults as food for its offspring.

Spiders (several species) which catch and feed upon the nymphs chiefly.

Birds (several species) that feed upon both nymphs and adults.

Chickens and turkeys that feed upon both nymphs and adults.

Of the two egg-parasites listed, *Ceratoteleia marlatti* Ashmead is the more important. From 20 to 50 per cent of the cricket eggs are destroyed each year thru this parasite alone. Neither of the two tachinids act as important checks upon the crickets, for comparatively few nymphs or adults are found parasitized by these flies. However, *Sarcophaga kellyi* Ald. acts as one of the most important means of natural control of some of our South Dakota grasshoppers. *Cephalobium microbivorum* Cobb is found in the intestine of a large number of our crickets, but it does not seem to injure them in any way that we could determine.

Paragordius varius (Leidy) infests only a small per cent of crickets and consequently cannot be regarded as an important check upon the numbers of crickets produced in a locality. We have found as many as five of these nematode worms in the body cavity of a single cricket. The protozoan, *Gregarina* (sp.?) is exceedingly common in the alimentary canal of immature as well as adult crickets. The number which we found ranged from one to more than one hundred per insect. It is the opinion of the writer that a heavy infestation with this parasite reduces the vitality of a cricket considerably, shortens its length of life and, if it be a female, limits egg production. The two parasitic mites which we listed cannot be regarded as economically important.

Chlorion cyaneum Dahlborn, a digger-wasp, does not occur in large numbers and, therefore, may be disregarded as an important check upon cricket increase. Spiders of several species are much more important for they capture and destroy large numbers of nymphs, especially those of the first four or five instars. Birds, likewise, destroy large numbers of crickets, but how important they really are in various sections of South Dakota we have not determined. Chickens and turkeys, when given the run of a field, exercise a controlling influence upon crickets. In a field of a few acres, such influence may be quite important but in a large field it tends to become negligible.

Measures of Control

Control measures for crickets have been directed along two lines; first, the destruction of the eggs and, second, the destruction of the immature and adult crickets. Of these, the former is the more effective and also the more economical.

To destroy the eggs, it is only necessary that they be exposed to the air, sun and wind for three to five hours. At the end of this time, they are shrunken and dead. Since the eggs are not laid deeper than one and one-half inches beneath the surface of the ground as a rule, and since they are laid singly and not in pods and are not protected by any special secretion, any process that will disturb the soil so as to bring the eggs to the surface will serve the purpose. Whatever treatment is given the ground, it should take place late in fall after the crickets are dead and again early in the spring before the eggs have hatched. In alfalfa fields a large number of eggs will be exposed to the elements and thus destroyed if a spring tooth harrow is run over the field first lengthwise, and then crosswise a few days later. The edges of such fields as well as the sides and tops of irrigation ditches should also be gone over.

Whenever grain fields become overrun with crickets, these should also be worked.

Our most effective method of destroying the black field cricket in any of its nymphal stages or in its adult form was thru a poisoned bait. In our experimental work we have tried out more than 50 different baits, which varied from one another in the ingredients used or in the proportions of the ingredients. We frequently were able to kill more than 50 per cent of the crickets in a field with one application of these baits but in no case did we succeed in obtaining what we considered a satisfactory kill.

The bait which we found most satisfactory was made up according to the following formula:

Bran	25 pounds
[3]White arsenic	1½ pounds
Black strap molasses	1 gallon
Water	3¾ gallons

Since the crickets feed chiefly from 4 p. m. till 8 or 9 a. m., the bait was put out late in an afternoon. In each case it was broadcasted by hand, 8 pounds (figured on the dry-bran content) being used per acre. In alfalfa fields the applications were made shortly after the first cutting of hay had been removed. In sections where irrigation was practiced, the fields were first irrigated and two days later they were baited, while in the non-irrigation sections, the bait was applied shortly after a rain had fallen. If this procedure is not followed a larger number of the crickets may remain in cracks in the ground and not come in contact with the bait. In spite of our most strenuous efforts, we never found it possible to obtain an accurate count of the number of crickets that were killed thru the baits, first, because the crickets may crawl into cracks to die and these cracks may be many feet in depth, second, because we have no way of knowing how many dead or perfectly healthy crickets are in these cracks, and, third, because many of the dead and dying crickets are carried away or eaten by other insects such as ants and unpoisoned crickets.

A series of experiments were conducted in which an attempt was made to destroy crickets in alfalfa fields thru the use of cyanogas calcium cyanide granules. This material contained not less than 40% nor more than 50% calcium cyanide. Forty pounds of the granules were used per acre, the material being applied thru a clover seeder on warm,

[3]We got just as satisfactory results by substituting paris green or sodium arsenite for the white arsenic.

still afternoons, after 4 p. m. Some of the fields had been irrigated several days previous to the treatment and were fairly dry on the surface, while others had not been irrigated. It is estimated that we did not kill more than 10 per cent of the crickets in any of these experiments. No injury was done to the alfalfa thru the insecticide.

Cocks or stacks of old hay or straw may serve as a place of refuge for thousands of crickets. If these be burned during the middle of the day by setting fire all around their basal edges, many of the insects are destroyed. Weeds cut, raked into piles and allowed to lie on the ground will also attract many of the crickets. Such weeds also should be burned.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The next paper is by D. N. Borodin.

PRACTICE OF ESTIMATING LOSSES CAUSED BY INSECT PESTS TO THE SMALL GRAINS IN RUSSIA

By D. N. BORODIN, *New York*

ABSTRACT

The practical need of determining losses caused by insect pests is recognized as an important part of the work of Economic Entomologists, Agronomists and Statisticians. Those insect pests which are invisible to a casual observer are probably the most important.

In order to determine the losses caused to certain plants by a given insect, an experiment of artificial infestation, with a future comparison of the check plants and infested plants must be made. The difference in weight of the yield of normal check plants and infested plants expressed in percentage is called "*Coefficient of Injury*" (*C*). The *Coefficient of Injury* is quite constant for certain insect pests. The *Coefficient of Injury* caused by a given insect might, and really should, be determined by experiments in a laboratory and must be done so once and for all.

The percentage of infested plants, or stems of plants in the field, is called "*Percentage of Infestation*" (*P*). Percentage of decrease in the yield, or "*Percentage of Loss*" (*L*) caused by a certain insect pest to a given crop in the field may be determined from the formula. The "*Actual Yield*" (*A*) per acre of a certain field and the "*Possible (theoretical) yield*" (*Y*) of grain from the same field when not infested may be also learned from the formula. The "*Actual Loss*" (*X*) caused by insect pests is the difference between theoretical and actual yields.

To know the exact cost of feeding a certain insect pest is especially valuable, if determined correctly. The quantitative side of the loss caused by insect pests is tremendous, but as yet unknown to the general public.

Not very much has been accomplished so far on the matter of the technique of estimating losses caused by insect pests to crops, in view of the fact that there is a conflict over a question of two distinctly

different specialties. For instance, the Economic Entomologist and the Agricultural Statistician often refer the matter of estimating the losses caused by insect pests to crops, or *Economic Entomological Statistics*,[1] to the sphere of the other.

The practical need of determining losses caused by insect pests has been noted by Agronomists of Russia primarily, in connection with the justification of expenditures on insect pest control and locust campaigns. The old Russian law provided compulsory work for the population in insect pest and rodent control, but later on this duty of the population has been replaced by hired labor, and questions for such an expenditure arose. The legislature had no doubt as to losses caused by locusts or rodents, when entire crop areas were devastated. The Legislature, however, was in doubt as to what to do when the insects devoured only part of the crops (as in the case of cutworms), and the same Legislature denied the necessity to combat invisible enemies, such as the Hessian fly.

The loss caused to small grains (which comprise the main field crops) by invisible, to the casual observer, insect pests attracted the attention of Prof. N. Lokot (1897), who determined the loss caused by the Joint fly (*Isosoma noxiale* Portch.), Hessian fly and European Sawfly (*Cephus pygmaeus* L.). His short remarks are of especial interest and value. Further data have been added and a terminology has been created by N. Kourdjumoff (1913) for experimental work in the fields.

The author studied the percentage of infestation by the European Sawfly in Stavropol-in-Caucasus (1913), and after one year's work on insect pests survey in Poltava Province, has insisted upon the necessity and value of those investigations (1914). This work has given him a possibility to add some formulas for the coefficient of injury and percentage of infestation (1921). A few formulas are now in genral use in Russian practice. Several formulas have been added by A. V. Znamensky (1924).

Coefficient of Injury

In order to determine losses caused to certain plants by a given insect, an experiment of artificial (or semi-artificial) infestation with future comparison of the check plant with the plants infested must be used. It is clear that both plants must be grown in absolutely the same condition, and in this

[1]The author uses this expression in print for the second time. (See D. N. Borodin: "First Report of the Activities of the Entomological Bureau and Insect Pest Survey of Poltava Province," page 17, Poltava, 1915.

case all conditions in the experiments (besides one—the activity of a certain insect) are kept intact.

Comparisons of the yield (or weight of seeds etc.), and if necessary, of the growth, general weight or chemical composition of various parts *of the check plant with that of the infested plant by a given insect, will determine the difference in yield*, or weight of seeds of a growth, chemical composition, etc.

If the weight of seeds of the check plant of spring wheat is to be "S" grams and weight of the plant in the experiment infested by European Sawfly (*Cephus pygmaeus* L.) will be "S_1" grams, the difference will be $S-S_1$. This *difference in weight of the yield of normal or check plants and infested plants, expressed in percentage, is called "coefficient or index of injury."* Let us indicate it by letter "C." The coefficient of injury may be determined according to the formula (1):

$$(1) \quad C = \frac{(S-S_1)\cdot 100}{S}$$

For the European Sawfly in relation to Spring Wheat the coefficient of injury is equal to 10%; or $C = 10$.

Symbolically, this can be expressed also in the following manner:

$$C \quad \text{European Sawfly} \longrightarrow \text{Spring Wheat} = 10.$$

or

$$C \quad \frac{\text{European Sawfly}}{\text{Spring Wheat}} = 10.$$

Notwithstanding the fact that the coefficient of injury depends upon additional conditions and is varied in many instances, this should not be confusing, for out of one thousand cases it is possible to take an average, but practically constant, figure.

This is especially correct for a large acreage, in which instance the coefficient of injury for certain crops and certain insect pests under normal conditions will be constant.

In the case of the European Sawfly, this conclusion is especially correct, in accordance with the author's investigations in Stavropol-in-Caucasus (1913). However, different grain varieties re-act upon the infestation from the European Sawfly in a manner which is not altogether similar, and this fact must be taken into consideration.

In cases of different insect pests the coefficient of injury varies, and deviates from a comparatively low percentage to 100.

Locust and some cutworms (for instance, *Euxoa segetum*) attack the plants, destroying them entirely, and the coefficient of injury in this case is 100.

At the present time, comparatively detailed studies have been made for few insect pests of small grains such as the Swedish fly, Hessian fly, *Chlorops taeniopus* Meig., *Meromyza saltatrix* L., *Adia genitalis* Schnab., *Chaetocnema aridula* Gyll., European Sawfly, Joint fly, and a few others.

Among chaotic data and large quantities of insect pests and the character of injury, its degree and extent, it will be impossible to ascertain all the necessary figures and bring them into order. The standardization of the character of injury will in this case be of especial value to obtain comparable data; then the extent of losses will be determined more easily and indicated by a rather short row of figures, numbering one to 100.

In the first case of the appearance of injurious insects in masses and especially in case, when they migrate in swarms, the coefficient of injury may be definitely estimated as 100, and losses will be calculated by simply multiplying the number of destroyed acres upon the average yield per acre of certain grains (taking into consideration the market price of certain grains).

In the second case, other insects, such as cutworms or webworms, which are always present in the field or on boundaries and obtain their food plants among weeds or wild vegetation, after an increase in their numbers, devour the plants, and this results in a great many patches along the fields. As in the previous case, the coefficient of injury is also 100, and losses must be estimated by determination of the acreage destroyed, multiplying it by the average yield per acre of certain grains and taking into consideration the market price of the grain.

The third and most difficult case is when insects do not destroy the entire plant, and the coefficient of injury is less than 100. This case must be paid special attention to, and is discussed here in greater detail.

Should it, however, be impossible to exactly estimate the injury, it might nevertheless be possible to establish a special standard scale (graphically, if necessary) of injuries, similar to the scale made up by Phytopathologists for rust and other cereal diseases.

A great many injurious insects have an ability to choose the most vigorous plant in the field, and are infesting and destroying only such, not touching the poor plants. In this case the presence of many infested plants results in no losses, which may be considered of any economical importance.

At times, the low percentage of infestation results in comparatively considerable losses from infestation by the same insect. This is especially true in a few cases, as for instance, with the Swedish fly.

In 1914 and 1916, infestation of oats and barley crops by the Swedish fly on the experimental plots of the Poltava Agricultural Experiment Station reached the level of 40%–70%, but this infestation has not caused a large loss, for only the side stems of the plants in an early stage have been attacked by the insect.

In 1913, on the contrary, the Swedish fly infested only 16% of the plants; however, loss in the yield was very serious, because the insect damaged the main stems of plants. This example shows that it is necessary to make a correction in the general formula, taking into consideration the circumstances or moment of infestation. In the instance with the Swedish fly, the coefficient of injury is different, depending upon whether the main stem or side stem is injured.

PERCENTAGE OF INFESTATION. Another deciding factor for estimating injury, and particularly to small grains, is the *percentage of infested* plants or stems of plants in the field, or the *percentage of infestation* by the insect. Let us name it by letter P.

The determination of this deciding figure does not present any difficulty even for a non-specialist. *The coefficient of injury by a given insect might be, and really should be, determined by experiments in a laboratory (in a very exact manner), and this must be done once and for all.*

The percentage of infestation might be determined by any correspondent under the direction of State Entomologists in a short time, after only minor instructions.

The examination of several hundred stems, taken from plants at different points of the same field, might in the majority of cases give basic data. The technique of determining the percentage of infestation has been worked out by the Entomological Division of the Poltava Agricultural Experiment Station. An average sample must be taken from a square meter or yard, or certain number of plants from the field. It has been found that the most correct *average sample may be taken in twelve points of a field, along the diagonal line reaching from one corner of the field to the other, by placing a ruler with meter lengths along the rows in twelve points and extirpating all plants from the row along the length of the ruler for future analysis*, in order to determine the precentage of infestation. The average number of the plants must be not less than 200.

Previously, the Entomological Division of the Poltava Agricultural Experiment Station has been using the American sampling method, consisting of five samples of twenty plants each, or 100 plants from a field.

The two-hundred samples of a plot have been considered as a minimum sample, and the increase of four times in the number of plants found desirable, but difficult for general use.

The percentage of infestation (P), in case that the total number of plants in a sample should be N, and the number of infested plants in the sample is n, it may be determined by formula (2):

$$(2)\quad P=\frac{n\cdot 100}{N}\quad \text{or}\quad (2_1)\quad P=\frac{(n_1+n_2+n_3+\cdots\cdots n_{12})\cdot 100}{(N_1+N_2+N_3+\cdots\cdots N_{12})}$$

In case of a two-hundred-plants sample and 20%–30% of infestation, the possible error (m) may be determined in accordance with the formula:

$$m=\frac{\sigma}{\sqrt{n}}$$

where σ is the main deviation and "n"—the number of variation.

In the Russian method with a 200-plant-sample, the theoretical error will not be more than 10%, and in case of 23% of infestation, it will be equal to: ±2, 3%, and the limits of possible deviation will be ±3m, 6, 9% on both sides.

Let us present a few figures as an illustration of the above said, as in case with the Hessian fly.

Total number of arshines* of the row in sample	Number of plants in sample	Percentage of infestation by Hessian fly	Main deviation	Coefficient of variation	Probable error in percentage
820	14325	38.72—0.58	22.63—0.37	58.45	1.40
60	1444	35.97—1.68	19.29—1.18	53.64	4.67
12	293	35.60—2.99	15.32—2.11	49.92	9.74

*Arshine—2 ft. 4 in.

The actual time of sampling is very important, and should be chosen when the injury is most pronounced. To take samples before the infestation, or to take them too late, when weather conditions might destroy the results of infestation, would be incorrect. The proper time for taking samples should depend upon the appearance of the adult stage (or winged stage), and length of development of the injurious stage of the insect. For determination of infestation of Spring Wheat by the Swedish fly, Hessian fly, *Adia genitalis*, samples must be taken during one month after mass appearance of the adult stage of the mentioned insects. For sampling to determine injury resulting from *Chlorops taeniopus* and *Meromyza saltatrix*, six weeks after their adult mass appearance is a most suitable time. Sampling may be made for each generation separately, if several generations of the adult stage appear. In case with the Hessian fly, the injury may be determined by taking samples in spite of the many generations,—only once before harvest time.

The analysis consists in determining the number of infested plants and stems or roots, etc., among the number of sample plants.

PERCENTAGE OF LOSS. Having the coefficient of injury of a certain insect and also having necessary corrections about the circumstances under which injury was caused (this being especially important in such cases as with the Swedish fly), and having determined the percentage of infestation of plants in the field, we are easily able to estimate the *percentage of the decrease in the yield or percentage of loss from certain insect pests of a given crop in the field. In this instance we may use one more formula where C is the percentage of loss:*

$$(3) \quad L = \frac{C \cdot P}{100}$$

The time of determination of percentage of infestation and circumstances affecting the coefficient of injury must be taken into consideration, and theoretical or actual loss from certain insects de facto will be less in cases of favorable weather conditions, fertilization and time of infestation. This factor will decrease the damage caused by the insect and not changing the percentage of infestation, will nevertheless affect the coefficient of injury. This enables us to ascertain the loss caused by the given insect to a state, region, province, the whole country, in fact, so long as there are available data from the census or usual agricultural statistics, such as acreage of certain crops, etc.

It behooves to mention that the majority of insects of a more destructive type and which cause constant injury are very distinctly distributed on the geographical map of the country, having a definite area of distribution. Before future estimating work can be attempted these limitations of distribution present additional data for determination of what is the *expenditure of the country in order to feed a certain insect pest,* and in this respect Ecologists will play an eminent part in *finding* the exact area for each injurious insect.

We always know the *actual yield per acre of a certain field. Let us indicate it by the letter "A." The possible (theoretical) yield of grain from the same field without infestation, or "Y," can be found according to the formula:*

$$(4) \quad Y = L \cdot Y + A$$

$$\text{or} \quad (5) \quad Y = \frac{C \cdot P \cdot Y}{100} + A$$

$$\text{or} \quad (6) \quad Y = \frac{100 \cdot A}{100 - C \cdot P}$$

The actual loss caused by the insect pest "$\propto$" will be in this case:

$$(7)\ \propto = Y - A$$

$$\text{or}\quad (8)\ \propto = \frac{100 \cdot A}{100 - C \cdot P} - A$$

In case of the presence of another insect pest or disease the losses must be determined for each pest or disease separately and afterwards combined. Formula (4) will be slightly changed as follows:

$$(4)\quad Y = L \cdot Y + L_1 \cdot Y + L_2\, Y + \cdots + A$$

Where L may be the percentage of loss from the European Sawfly, L_1 is the loss from Joint fly, L_2 the loss from a certain fungous disease. The presence of combined pests and diseases will affect the actual yield "A," which will be larger in such cases. *The destructive effect of such combined infestation and of the correlation between* L, L_1, L_2, *is a field for future research work.*

The distribution of insect pests bears a distinctly zonal character in a great many cases, and is dependent upon the climate and vegetation, i.e. the temperature, moisture and especially—food. Ecologists have often very correctly passed upon boundaries of the distribution of insects.

It is not difficult for a statistician to ascertain the acreage of a given cultivated plant in boundaries of areas of its distribution, and for Entomologists to determine the percentage of infestation, by using the assistance of county agents or special correspondents.

Conclusion. Information regarding average yield, of market prices should always be at the service of persons interested, and in this manner the activities of a majority of insects may be expressed in Dollars (or in any other denomination of the respective countries).

Injury caused in Russia by Locust, *Anisoplia austraica* Hrbst., *Euxoa segetum* Schiff., or *Locusta migratoria* L. is evident to every one: the insect attacks, devours, and is being caught in his criminal act. The pest is brought before the eyes of farmers; the injury is quite evident, and the loss may approximately be estimated by the owner of a field.

But every year a great many insects, not seen by the naked eye of the farmer, together with fungous and bacterial diseases, destroy the greater part of his labor, and in numerous instances the State Legislature does not possess any idea of the amount of money lost by farmers on account of insect pests and plant diseases. *To know the exact cost of feeding certain insects is especially valuable, if estimated correctly.*

The economic importance of the exact knowledge of losses caused by insect pests is now recognized. The quantitative side of these losses has been splendidly and definitely determined by Dr. L. O. Howard in his speech at the Pan-Pacific Food Conservation Conference, Honolulu, Hawaii, in 1923 (a report of this speech has been published in the journal "Science"). This was a most powerful encouragement for Economic Entomologists and a real discovery for the general public. Appreciation of the work done by Economic Entomologists is now growing.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The next is a paper by E. N. Cory and P. D. Sanders.

STATUS OF THE POTATO TUBER MOTH IN MARYLAND[1]

By ERNEST N. CORY and P. D. SANDERS, *College Park, Md.*

ABSTRACT

The potato tuber moth, *Phthorimea operculella* Zell., a newly established pest in Maryland, did considerable injury to late planted potatoes. Climatic conditions have apparently influenced the abundance of the pest. Some of the more important sources of carryover have been investigated. Cultural and harvesting measures, together with cleanup practices, are suggested.

INTRODUCTION

The unusual severity of the attack, the universality of the distribution of the pest within limited areas and apparently the marked influence of climatology on the activities of the insect make the status of the potato tuber moth especially noteworthy.

The first finding of the insect as a potato pest in Maryland occurred at Pocomoke in a storage house on December 20, 1923. In an adjoining field larvae were found in cull potatoes on the same day. Evidences that were indicative of the insect having been present were found also in a field near the Maryland-Virginia line, immediately south of Pocomoke.

DISTRIBUTION

To date this insect has been found as a pest of potatoes in four counties on the Eastern Shore. Three of these counties, Worcester, Somerset and Wicomico, particularly the two former, constitute our principal early potato growing section. The fourth county, Talbot, in which two isolated infestations have been located, is not a shipper

[1] *Phthorimea operculella* Zell.

of potatoes, and so far we are at a loss to account for the infestations there. Worcester County is adjacent to the Virginia line, in which is located one of the two large potato exchanges which handle the bulk of the potatoes from the Eastern Shore of Virginia and Maryland, the other being located at Onley, Va. Both exchanges have members in each state, and pack potatoes that are grown either in Maryland or Virginia, so that there has been a possibility of the free exchange of infested material during the period when the insect has been known to be present in this territory.

The tobacco split-worm has been recorded from Maryland, and since those who have worked with this pest feel that it is identical with the potato tuber moth, the distribution in this state should include those records.

Extent of Injury to the Potatoes

Our 1923 records show no injury to potatoes. During 1924 an inspection of fifty-three fields in Worcester and Somerset county failed to disclose any injury or evidence of work of the pest. Inspection of potatoes for certification as to freedom from potato wart in June, 1925, also failed to disclose the presence of the moth in any of its stages, but on July 18 an inspection of a packing house at Pocomoke revealed the presence of twenty-two barrels of cull potatoes that had been sent in from Virginia as field run potatoes, for regrading, with a heavy infestation in all stages. This lot of potatoes was burned. Later, however, a federal inspector reported the presence of a tuber moth larva in one car of potatoes originating in Somerset County. Beginning September 22 an inspection of 107½ acres on twenty-two farms revealed tuber moth adults and larvae present in every field visited. These fields were being grown for certified seed potatoes, and accordingly certification was refused. The heaviest infestation was near the Virginia line in Worcester County and in lower Somerset County, gradually diminishing northward.

In these late potato fields the injury from drouth and tuber moth was so severe that some fields were plowed down without any attempt to dig the tubers, and in others the tops were so badly injured that the fields had the appearance of being blighted and the crop was greatly reduced, first by drouth, followed by insect injury.

Where the tops or vines were dead and lying flat on the ground hundreds of larvae could be found on the soil surface searching for food. Where a shallow system of cultivation was used and tubers were exposed the migrating larvae entered them. As high as seven

"green" larvae were found entering a partially exposed potato at one time; four and five were common. Invariably the foliage was injured more near the edge of the fields than in the center. Along the edge of woods the larval tunnels were more abundant in the stems and stalks. In heavily infested fields walking through the vines at nightfall stirred into flight thousands of moths.

In the heavily infested district the injury ranged from total loss to slight injury. The injury in storage has not been calculated.

Climate

The amount of rainfall and the temperature apparently have a marked effect upon the tuber moth infestation. Possibly rainfall is the more important of the two. Taking the records of rainfall at Princess Anne, which is near the heavily infested district, from November through October of the succeeding year, we find that in 1923 and 1924 the total rainfall was 47.83 inches, with 24.35 of this occurring from March 17 to July 20, the period of the first crop. From July 20 to the harvesting of the second crop 9.53 inches of rain fell apparently allowing for a multiplication of the insects to the point where they were capable of causing injury under favorable conditions in the crop year of 1925. From November, 1924, through October, 1925, a total of 36.56 inches fell. From March 17 to July 20, 1925, only 10.08 inches fell and the heavy infestation at the end of the first crop would seem to indicate that the dry conditions were favorable for the multiplication of the insect. From the end of the first crop to the harvest of the second crop 13.05 inches fell. The rainfall of 1923 and 1924 was above the average, though not equal to that of 1921, which was 51.29. The pest multiplied abundantly during the second crop, so it may be assumed that thirteen inches is not too much for a maximum multiplication, especially since the season was very dry during the height of the growing season.

Possible Sources of the Carry-Over

An investigation of farms upon which infestation occurred, and in and around packing houses or railroad sidings disclosed many piles of cull potatoes in which the tuber moth in all stages occurs. Many cull potatoes are dumped in wood lots on the farms and being more or less protected by leaves and rubbish undoubtedly will allow for a carry-over of the pest.

In fields where potatoes have not been picked up thoroughly it is quite common to find partially exposed tubers that are infested even after severe freezes have destroyed the exposed portion of the tubers.

The practice of putting potatoes in kilns or banks, without doubt, permits uninterrupted development of the larvae. Whether the pest can live over in any stage other than as larvae has not been ascertained, but it is probable that other stages may survive the winter in a favorable location.

Measures Advocated to Prevent Infestation

Since other workers have found that most of the tuber moth eggs are deposited at night, a radical change in the method of handling potatoes has been suggested for the area where the tuber moth is known to be present, with the purpose of insuring the picking up, barreling and hauling from the field of all potatoes plowed out during the day, to the end that no potatoes will be left exposed overnight to possible egg laying. In this connection we have also recommended the discontinuance of the practice of placing vines on the tops of barrels to prevent sunscald, and in place thereof have recommended the covering of the barrels with burlap as soon as the barrel is filled, turning the barrels on the side, to avoid sunscald, and removal from the field before nightfall. We believe that potatoes so handled can be sent out with reasonable assurance that they will be free from tuber moth upon reaching the ultimate consumer. We expect to certify potatoes only on the basis that they have been handled as above outlined, since no practicable inspection would determine whether the the potatoes were free from eggs or larvae. In addition to harvesting the crop as above outlined, the following suggestions have been carried to the growers in a series of meetings through the infested territory, and by means of a circular and a poster: (1) All potatoes badly infested in the spring should be destroyed; (2) Keep the potatoes well ridged to avoid tuber infestation before harvesting; (3) Dig before vines are dead if possible, but if harvest is delayed until vines are dying, give adequate ridging; (4) Spray or dust with arsenicals or combination of Bordeaux and arsenicals; (5) Use mechanical diggers; (6) Absolute cleanup of potatoes after each harvest.

A thoroughgoing study of the life history and control of this insect, both in field and storage, is now under way in the heavily infested territory. The universal interest of the growers in preventative and control measures is unique in the annals of Maryland entomological effort. The cooperation of the growers and all agencies having anything to do with the handling or selling of the potato crop is assured, and any methods that may be developed either in Maryland or elsewhere that will give any assurance of preventing infestation or reducing the

injury to potatoes in storage or transit will be put into effect promptly and thoroughly by those interested in the potato crop.

MR. W. J. SCHOENE: The tubermoth was found in Virginia in 1923. In 1924 the weather was apparently very favorable to potatoes and unfavorable to this insect and the growers harvested the largest crop of potatoes in the history of that section. According to market reports, there were, I believe, 23,000 cars of potatoes sent out and no reports of injury. I inspected myself, and also the men from my office, a great many fields of potatoes and we found no evidence of tubermoth except in one or two fields after the potatoes had been dug. The season of 1925, as Mr. Cory has told you, was exceedingly dry. I think perhaps it was the driest weather we have ever had. The early crop was harvested with practically no loss—I don't know just what the loss was. I remember distinctly the weather cut down the crop of potatoes somewhat, but up to the middle of July there had been 5,500 cars shipped by the Exchange on the eastern shore and only three complaints up to that time. No rains occurred during the late crop of potatoes, which is a seed crop, and this very seriously reduced the crop. The plants only got ten inches or a foot high on account of the drought. Some fields were plowed up, but I think most of the fields made a small crop.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The next paper is by C. O. Eddy.

THE MEXICAN BEAN BEETLE IN SOUTH CAROLINA

By C. O. EDDY, *South Carolina Experiment Station*

ABSTRACT

The activities of the Mexican bean beetle (*Epilachna corrupta* Muls.) in South Carolina during the year 1925 are reported. Extreme drouth prevailed so activities were more limited than in previous years. Cage and field emergence studies showed that emergence of adults assuming normal feeding and breeding activities occurred during May and June. Fourteen and two-tenths per cent of the adults emerged from the hibernation cage.

One generation developed and all the adults died before the period for hibernation arrived. A second generation developed, many of the adult females laid eggs during a short period, and then the majority of the adults went into hibernation. A small number of third generation beetles developed and went into hibernation. A very few females of the third generation produced eggs. A few individuals of the fourth generation appeared but produced no eggs.

Host plants, during the spring and summer, were chiefly string or snap beans

and to a lesser extent lima beans. In September and October they were found developing on cowpeas just before going into hibernation. Many larvae in the first and second instar died in August from what appeared to be a bacterial disease. The ladybird beetle, usually called *Megilla maculata*, destroyed portions of many egg groups.

The Mexican bean beetle (*Epilachna corrupta* Muls.) entered South Carolina in 1921. Since that time it has spread east and southeast at the average rate of about thirty-five miles per year with the exception of the year 1925 when no additional records of damage beyond the limits established for 1924 were made.

The active season of the Mexican bean beetle for 1925 has been an unusual one, hence a few statements are made first concerning weather conditions.

The mean monthly temperatures for 1925 for Clemson College, South Carolina, varied very little from the average monthly means for the previous thirty-two years.

The rainfall for 1925 at Clemson College, however, was approximately sixty per cent of the average for the preceding thirty-two years, with January, October, November and December having considerably more than the average. May, June, and July had about one-third of the average rainfall, and August but about one-seventeenth of that for the preceding thirty-two years. Host plants of the Mexican bean beetle either did not grow or wilted and died and additional seed were not planted during this period. Larvae of the Mexican bean beetle died in a short time when exposed on wilted plants, and in a few minutes, if they fell on soil exposed to the sun.

The life history studies were made under very extreme conditions of rainfall, hence it may be expected that the records will vary from those of a normal year. South Carolina is now on the edge of the area of distribution of the Mexican bean beetle, thus adding another extreme condition which may also give records different from those which would be obtained in places nearer the center of distribution. There still seems to be less information concerning this insect than many other species of no more economic importance.

Hibernation Studies

Cage Method

A small number—450—Mexican bean beetle adults were collected in 1924 during the period when they were going into hibernation during late September and the first part of October. They were placed in a boll weevil hibernation cage in a well-drained woods of second-growth

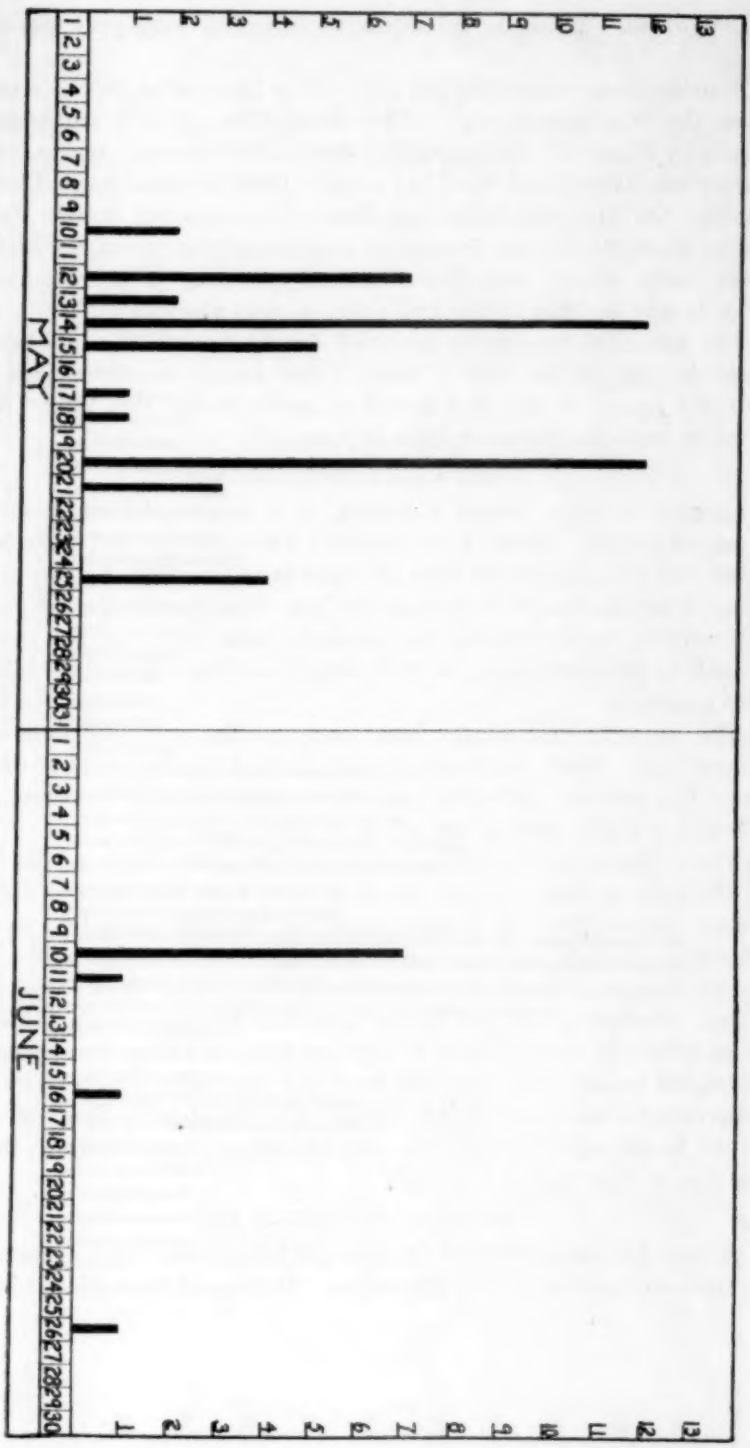


FIG. 4.—Distribution of emergence of Mexican bean beetle adults from hibernating cage, spring, 1925.

pine and oak. A very light covering of branches and leaves was in the cage.

Fourteen and two-tenths per cent of the hibernated beetles emerged from the hibernation cage. The distribution of this emergence is shown by Figure 4. Occasionally a few beetles emerged, one at a time, during late March and April but none of these assumed normal feeding habits. On May tenth the first beetle that assumed normal feeding habits when placed on a bean plant was taken from the cage. Mexican bean beetle adults were found normally feeding in the gardens on May 11 and on May 13 the first group of eggs was located.

The principal emergence occurred during the middle of May and from the 10th to the 16th of June. There are no records for late May or early June. A long dry period occurred during this time. A few showers preceded the emergence in June.

Field Collection Method

Clemson College, South Carolina, is a community of about five hundred people. Most of the families have gardens and grow beans. Since this area is isolated from all other bean growing areas by several miles, it was decided to collect beetles from these gardens for the purpose of studying the arrival of the Mexican bean beetle in the gardens, as well as the distribution of their emergence from all sorts of hibernation quarters.

The records were made from each garden approximately every second day. Each day's record was divided by the number of days since the previous collection and the results recorded between them. There is a slight error in not taking a record each day.

The collection of normally active Mexican bean beetle adults began in the field on May 11, one day later than from the cages. Figure 5 shows graphically the records made by the field collection method. The daily records increased until May 24 when a decline began. The heavy emergence in May occurred a few days later than it did in the cages. Excluding the first day of June, the largest arrivals of Mexican bean beetles in the field were in the first third of June. This emergence decreased rapidly after the 12th until the 29th, after which no emerged hibernated adults were found. There was considerable flying of adults in the latter part of June, thus possibly causing some error in the last portion of this chart.

Seasonal Activity in 1925

A record of the activity of the emerged hibernated beetles is presented in the lower section of this illustration. Between March 26 and May 10

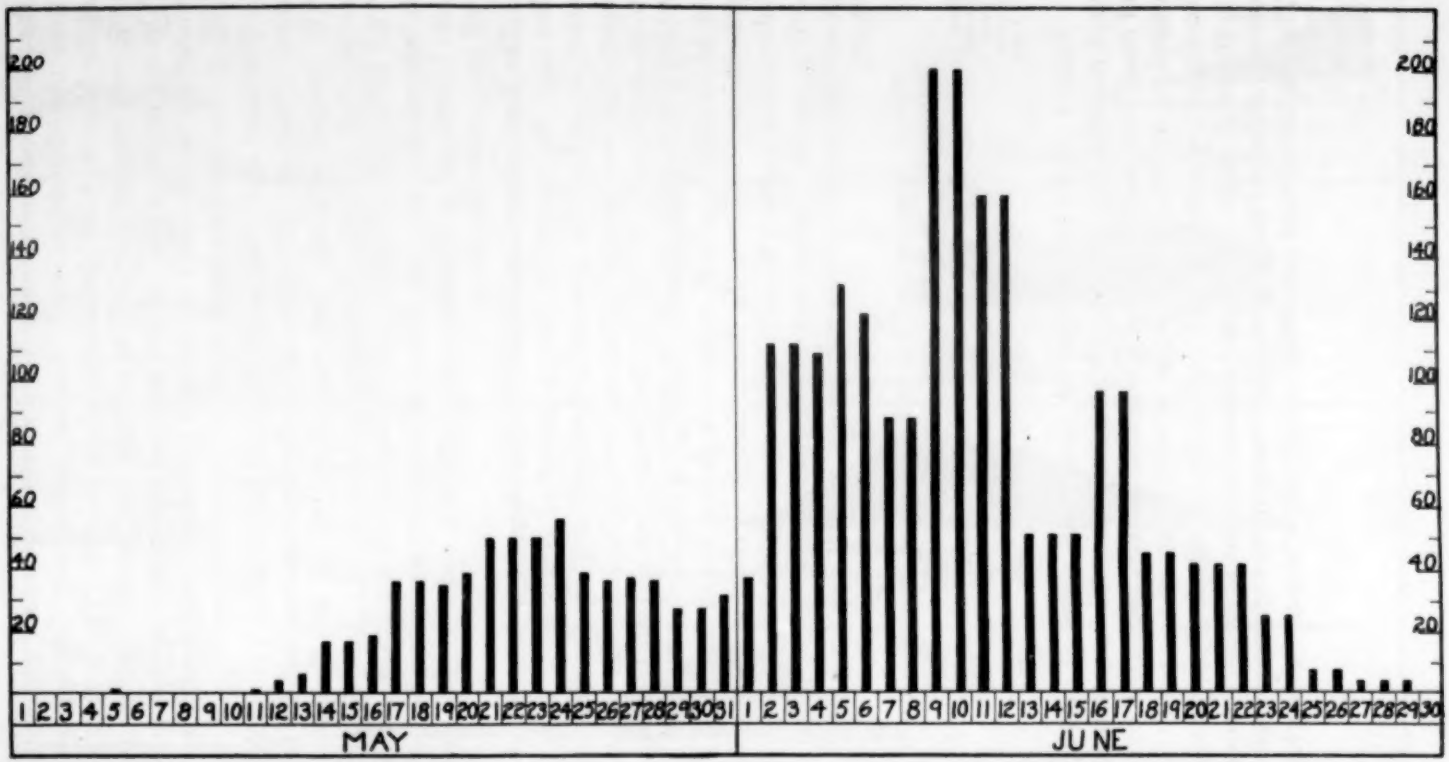


FIG. 5.—Distribution of the arrival of Mexican bean beetle adults in the bean fields, spring of 1925.

the adults were occasionally found in the field or as single emergences from the hibernation cage. Normal feeding and breeding activities of the Mexican bean beetle began about May 10. The crest of infestation was reached on June 14 and the last female died on July 20. The egg-laying period for the emerged hibernated beetles, as shown under the development of the first generation, was from May 13 to July 8, or a total of fifty-six days.

The chart shows the period occupied for larval and pupal development. The first adult of the first generation appeared then on June 15. The crest of infestation was reached on July 23 and the last female on test died on October 8, making a total period of 115 days of activity. This generation developed and lived its entire life in one season. It is believed that very few or none of these first generation beetles went into hibernation at Clemson College this fall, and if so, they probably will not survive the winter.

The first generation adults laid their first eggs June 28 and the last eggs September 23, over a period of eighty-seven days. The chart shows how this generation developed and how the crest of adult infestation was reached on September 4. The last pupa transformed to an adult October 3. Most of the beetles went into hibernation. The adults of the second generation laid eggs over a short period from August 14 to October 4, a total of fifty-one days. The development of this generation is shown by the chart. Nearly all of these adults went into hibernation quarters without laying eggs. Of the few eggs deposited, only a portion hatched, consequently only a few beetles of the fourth generation appeared. This number is so small it does not appear on this chart.

TABLE 1. NUMBER OF CASES USED FOR FIGURE SHOWING DEVELOPMENTAL DATA

Generation	Incubation period	First instar	Second instar	Third instar	Fourth instar	Pupa
First	2553	1874	1576	463	208	201
Second	1986	1789	1744	1744	1744	1746
Third	610	58	58	58	58	73
Fourth	29	18	10	10	8	6
Total	5178	3739	3388	2275	2018	2026

Table 1 shows the number of cases of all stages of development used in computing the data for all generations. The greatest number of cases were used in the early stages of the first generation but these decreased rapidly, partly because of natural factors and partly because no attempt was made to carry all of the individuals of any group thru to the adult stage. A definite attempt was made to carry more individuals of each of the groups thru to maturity in the second generation. The number of third generation cases is small because its development

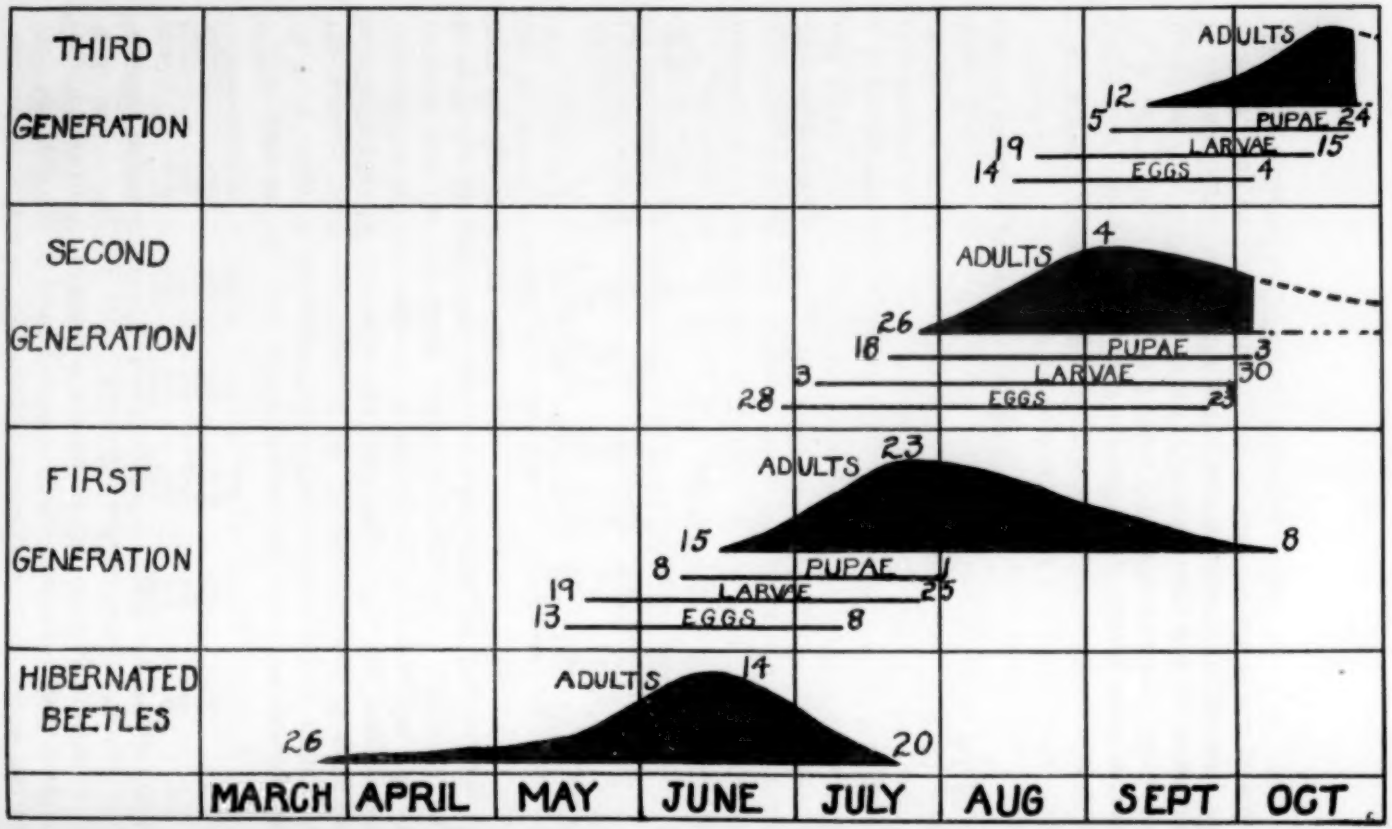


FIG. 6.—Summary chart of seasonal history of Mexican bean beetle, 1925.

occurred very late in the season. Third generation adults laid but very few eggs and as great numbers of these failed to hatch, very few records were made for the development of the fourth generation.

TABLE 2. AVERAGE LENGTH OF DEVELOPMENT BY DAYS

Generation	Incubation Period	First instar	Second instar	Third instar	Fourth instar	Pupa	Total
First.....	6.10	5.23	3.61	3.54	3.64	6.03	28.13
Second.....	5.57	3.67	3.39	3.55	3.90	7.46	27.54
Third.....	6.09	3.81	3.21	3.43	3.67	8.13	28.34
Fourth.....	5.00	3.00	4.00	4.00	3.00	11.00	30.00
Average...	5.69	3.93	3.55	3.63	3.55	8.13	28.50

The body of this chart shows the average period of development for each stage of all generations. The column on the right gives the average total time required for the development of each generation, while the figures across the bottom give the average time required for the development of each stage for the season. It will be seen that the incubation period averages about 5.69 days, each larval instar between three and four days, and the pupal stage 8.13 days, making a total of 28.50 days.

TABLE 3. SUMMARY OF EGG LAYING ACTIVITIES

Beetles	No. females used	No. females laying	% females laying	Total egg groups	Av. egg groups per fem.	Total eggs	Av. no. eggs per fem.	Max. eggs 1 fem.	Min. eggs 1 fem.
Hibernated.....	60	52	80.6	219	3.65	9398	156.6	770	0
1st Gen.....	23	23	100.0	260	11.30	11672	507.5	1493	120
2nd Gen.....	17	16	94.1	61	3.60	2404	141.4	363	0
3rd Gen.....	5	3	60.0	6	1.20	194	38.8	102	0
All gen.....	105	94	89.5	546	5.20	23668	225.4		

A record of the egg-laying activities of the number of females recorded in the first column of Table 3 is shown in the succeeding columns. It is noted, for instance, that eighty per cent of the hibernated females, on test, laid eggs. One hundred per cent of the first generation laid, ninety-four per cent of the second, and sixty per cent of the third.

It can be seen that in the last columns the activity of the first generation females is much greater than that of any others. The activity of the emerged hibernated females comes next but is considerably less. The activity of the second generation females ranks third, and that of the third generation females fourth.

HOST PLANTS

During the season of 1924 the Mexican bean beetle was found on many host plants other than beans and larval development occurred on several of these. In 1925, however, the Mexican bean beetle was found only on bean plants (snap or bunch beans and less abundantly on lima beans) during the spring and summer. In the early fall, however, they were found developing on cowpeas and it was here that they were collected for hibernation studies.

Predators and Diseases

The ladybird beetle, usually called *Megilla maculata*, was active in destroying portions of many groups of eggs. What appeared to be a bacterial disease killed many larvae in the first and second instar, chiefly during the month of August when the driest period occurred.

Mr. J. H. Bigger: Don't you think you would have gotten a different development in the second generation if you had had more rainfall?

Mr. C. O. Eddy: We did have different results in 1924, and the results probably depended on the difference in climatic conditions.

Mr. W. E. Hinds: I think this is an item of interest in connection with the bean beetle in its eastern and western habitats: The first year of general occurrence in Alabama, breeding was continuous until after the first of November at the time of the killing frost. The next year they stopped breeding early in August. I think it is a case where an insect has wandered out of its natural habitat, upsetting a good many of its original habits and hasn't yet settled down to a life in the East.

Also the matter of distribution in altitude might be of interest. I believe in the West distribution of between perhaps 1500 to several thousand feet is very common. In the East it occurs at an elevation of 150 feet and has shown its ability to maintain itself and spread slowly even at that low elevation.

Mr. G. M. List: Speaking of the second generation, I have had a little experience in some of our work in Fort Collins. I don't know whether it has any significance or not. In 1923 we carried through some life history work on the bean beetle. We reared local material from right there in our own field, and alongside of this we reared some beetles that were sent in from Alabama. In every respect the first generation of each lot of material was about the same. The length of all periods was within fractions of a day the same. When it came to the second generation, there was a great difference, apparently, in the number of eggs laid. We had only part of them forming a second generation, or rather a small second generation, but the second generation beetles of the Colorado material laid thirteen and a fraction eggs each. The Alabama second generation beetles laid eighty some odd. I don't know whether that has any significance or not, but they were carried side by side in the same insectary.

Mr. D. M. DeLong: The distribution in Ohio has been rather

interesting. I am going to mention it because of the ecological factors concerned. Where the beetle has been found for three years in central Ohio, there are so few of them present that it is very difficult to find them in the field. If you go ten miles from this region where they are hard to find, they are so abundant that in fifteen minutes' time you can collect 4,000 of them from a row of beans about a hundred feet long. The ecological factors in that distribution, I think, are going to be important in deciding where the beetle will be found. In the central part of Ohio and the northwestern portion, the beetles are not found in the flat country, but they have worked their way northward to Lake Erie through the Ohio River Valley and the hilly portions of the state and have then worked back along the lake shore as far west as Cleveland.

There is an ecological factor that is controlling very decidedly the distribution.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The next paper is by C. F. Doucette.

THE EFFECT ON NARCISSUS BULB PESTS OF IMMERSION IN HOT WATER

By CHARLES F. DOUCETTE, *Junior Entomologist, Fruit Insect Investigations, U. S. Bureau of Entomology*[1]

ABSTRACT

Unsupported statements that immersion of narcissus bulbs in water kept at a temperature of 110° to 111°F. for three hours would be fatal to bulb flies and bulb mites induced experimental work to determine the effectiveness. The trials gave satisfactory evidence that these statements were true and indicated that a much shorter time was required to obtain a complete mortality of the larvae of the two bulb flies and also of the bulb mites.

At the present time the most satisfactory treatment recommended for the control of the stem- and bulb-infesting nematode, *Tylenchus dipsaci* Kühn, in narcissus is immersion of the bulbs in water held at a temperature not lower than 110°F. or higher than 112°F. for a period of at least three hours. This treatment has become more or less general among growers in this country, in England, and in Holland, and in many sections the bulb vat is considered part of the equipment necessary for growing bulbs. Various technical articles concerning the nematode and some catalogs of dipping equipment state that the treatment as de-

[1]The writer appreciates and acknowledges the cooperation shown by the California Department of Agriculture in placing at his disposal for these experiments an electrically heated and thermostatically operated vat designed by Mr. D. B. Mackie and Mr. H. Stiner of that department.

scribed above kills the bulb flies and the bulb mites. Since no experimental data have been published to support such statements, a number of tests were made with infested narcissus bulbs to determine what effect immersion of the bulbs in hot water would have on the pests. Lots of bulbs were immersed in water of different temperatures and for various periods of time. The observations were made on the larvae of the narcissus fly, *Merodon equestris* Fab., on the larvae of the lesser bulb fly, *Eumerus strigatus* Fallen, and on all stages, except the egg, of the bulb mite, *Rhizoglyphus hyacinthi* Boisd. In control experiments or "checks" no mortality occurred when larvae of both flies were submerged in tap water at room temperatures (60° to 70°F.) for ten hours or when mites were similarly submerged for twenty hours. The results of these trials are given in Table 1.

TABLE 1. RESULTS OF IMMERSION IN HOT WATER OF BULBS INFESTED WITH LARVAE OF *Merodon equestris*, LARVAE OF *Eumerus strigatus*, AND BULB MITES, *Rhizoglyphus hyacinthi*

Temperature	Period of immersion	*M. equestris* larvae			*E. strigatus* larvae			*R. hyacinthi*
		No. Dead	No. Alive	Mortality	No. Dead	No. Alive	Mortality	Observations on condition
°F.				Percent			Percent	
100	1 hour	1	8	11.1	8	46	14.8	
	2 hours	3	13	18.75	31	6	83.8	
	3 hours	6	4	60.0	21	3	87.5	
105	15 min.	0	9	0.0	0	21	0.0	Many live mites
	30 min.	0	3	0.0	5	39	11.3	Many live mites, a few dead
	1 hour	5	12	29.4	103	4	92.5	All dead except two
	2 hours	17	0	100.0	104	0	100.0	No live mites found
	3 hours	32	0	100.0	93	0	100.0	ditto
110	5 min.	0	8	0.0	0	20	0.0	
	10 min.	1	20	4.8	21	115	15.4	Many live mites
	15 min.	0	11	0.0	12	11	52.2	
	20 min.	3	14	17.6	75	35	68.2	No live mites found
	25 min.	—	—	—	—	—	—	ditto
	30 min.	13	5	72.2	54	0	100.0	ditto
	40 min.	9	0	100.0	19	0	100.0	ditto
	50 min.	11	0	100.0	42	0	100.0	ditto
	1 hour	16	0	100.0	137	0	100.0	ditto
	1½ hours	5	0	100.0	122	0	100.0	
	2 hours	13	0	100.0	151	0	100.0	
	2½ hours	6	0	100.0	212	0	100.0	
	3 hours	13	0	100.0	70	0	100.0	
114	10 min.	4	6	40.0	48	6	88.8	
	20 min.	3	0	100.0	21	0	100.0	
	30 min.	13	0	100.0	94	0	100.0	
	45 min.	8	0	100.0	27	0	100.0	
	1 hour	12	0	100.0	95	0	100.0	
	1½ hours	16	0	100.0	82	0	100.0	
117	10 min.	5	5	50.0	15	0	100.0	No live mites found
	20 min.	13	2	86.7	18	0	100.0	ditto
	30 min.	11	0	100.0	21	0	100.0	ditto
	45 min.	13	0	100.0	13	0	100.0	ditto
	60 min.	14	0	100.0	15	0	100.0	ditto
118	30 min.	6	0	100.0	103	0	100.0	
	1 hour	8	0	100.0	66	0	100.0	
	1½ hours	10	0	100.0	168	0	100.0	
	2 hours	9	0	100.0	97	0	100.0	
120	10 min.[1]	10	0	100.0	42	0	100.0	No live mites found
	10 min.[2]	3	3	50.0	45	5	90.0	Live mites numerous except close to surface
	20 min.	5	0	100.0	75	0	100.0	No live mites found
	30 min.	14	0	100.0	116	0	100.0	ditto
	45 min.	9	0	100.0	25	0	100.0	ditto
	1 hour	12	0	100.0	100	0	100.0	ditto
	1½ hours	15	0	100.0	120	0	100.0	ditto

[1]Small moderately soft bulbs.
[2]Large firm bulbs.

The information in the table substantiates the statements that the standard three-hour treatment at 110°F. is fatal to the fly larvae and mites. The number of trials and the number of individuals observed at the temperatures indicated are sufficient to make the results fairly conclusive. The experiments show that a temperature of 100°F. is too low to give complete mortality within three hours. At 105°F. the treatment should last at least two hours to insure complete mortality. One hundred percent mortality is obtained in all immersions of forty minutes and longer at 110°F. Where the temperature of the water was above 110°, viz., 114°, 117°, 118°, and 120°, immersions of thirty minutes gave complete control. The two trials of ten minutes each at 120° in which lots of small and large bulbs were used indicate that the heat penetrates the larger bulbs slowly as shown by the incomplete mortality of both species of fly and the position of the mites found alive in the larger bulbs.

To furnish further proof of the efficacy of the hot water treatment in killing the fly larvae and mites, examinations were made of infested bulbs sorted from lots treated by growers at several places in California. In no case were any live mites or larvae found in bulbs given the regular treatment. Several hundred larvae and a large number of mites were observed in these examinations.

The effect of the hot water treatment on the bulbs also deserves consideration. For several years growers in England and Holland have subjected propagating stock to the standard three-hour-110°F. treatment. A large number of bulbs given similar treatment are now growing satisfactorily in Santa Cruz County, California, and are under the writer's frequent observation. There are two plantings where bulbs treated at 114°F. for three hours show no ill effects. One experimental treatment should be mentioned since it indicates that there is considerable leeway with the hot water treatment. On October 9, 1925 some King Alfred narcissus bulbs were dug with new roots two to three inches long. After treatment for three hours at 110° on October 15 they were kept wrapped in moist cheesecloth until October 19 when they were planted. During the four days between treating and planting several of the roots had pushed through the cloth as far as one-half inch. These bulbs are now growing apparently in good condition. The theory has been held that treatment after the roots are started is detrimental to the root tips, but this experiment would indicate that such is not the case.

The results herein reported are not presented as a basis for recom-

mendations for full control of the several pests involved, since several factors make it impossible to obtain complete control by this one method. The hot water treatment serves, however, to reduce the population of these insects considerably, and assures the grower that his planting stock is clean.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The next is a paper by V. E. Shelford.

METHODS FOR THE EXPERIMENTAL STUDY OF THE RELATIONS OF INSECTS TO WEATHER[1]

By V. E. SHELFORD, *Champaign, Ill.*

ABSTRACT

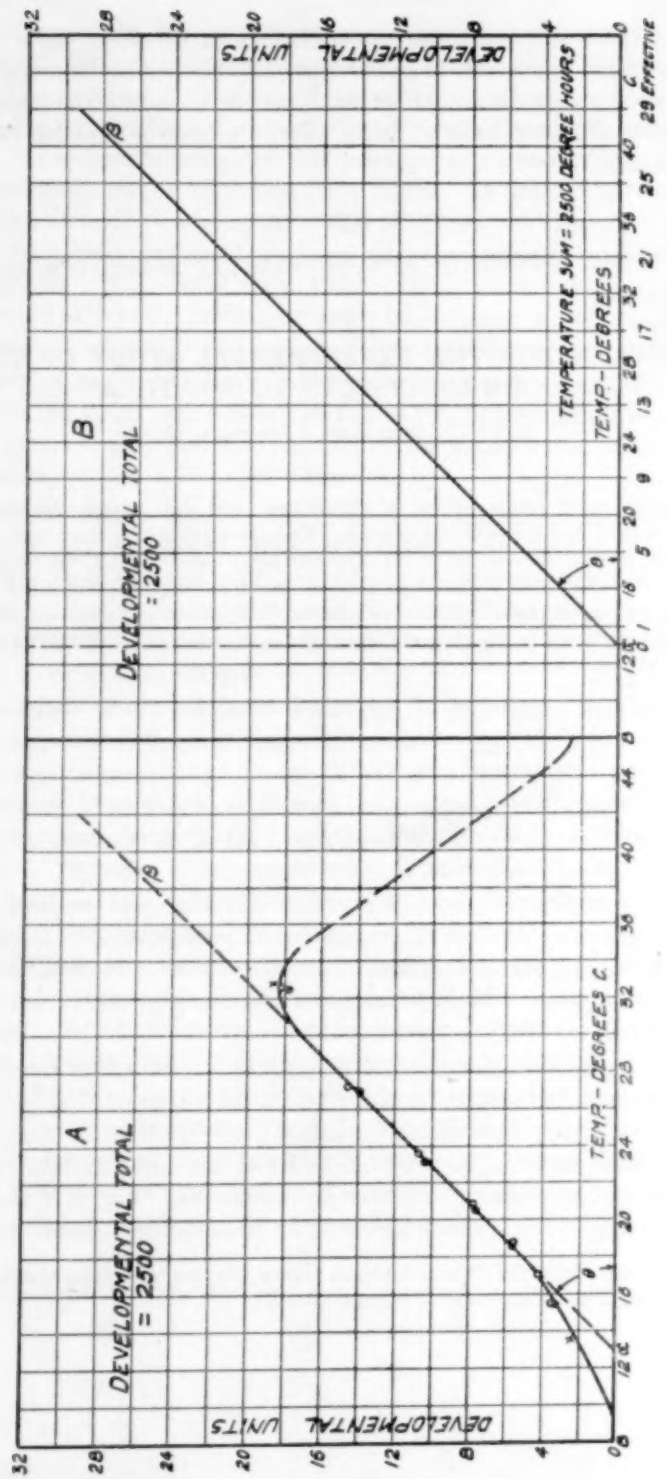
The summing of temperatures is abandoned, and degree-hour developmental units are substituted for effective degrees. The variation in the character of stocks to be used is such that a full series of about sixty experimental combinations of temperature and humidity should be applied to the same generation, when relative effects of the various combinations is desired. Continuous quantitative collections correlated with weather records will throw light upon weather effects. The founding of a well endowed laboratory for such work is suggested.

The purpose of studies of the relations of insects to weather is to predict the time of appearance of stages to be subjected to spraying or to predict the abundance of a pest or its enemies at some near future time. In such studies, field observations, as well as experiments are essential, but the older methods of phenology and temperature summing, must either be greatly modified or abandoned.

The idea, now centuries old, to the effect that temperature can be summed so as to give approximately the time of development of a particular organism, must be abandoned wherever accurate results are desired. This method is likely to fail more or less completely in the unusual seasons when accuracy is most needed.

To illustrate the falsity of the assumption upon which temperature summing rests, the work of Krogh ('14) on the pupae of *Tenebrio molitor* may be cited. Fig. 7 A, shows the actual velocity curve for the development of these pupae. The solid line is drawn through the data of Krogh and extended to conform to other known curves. Fig. 7 B, shows the velocity curve which would be assumed in summing temperatures for

[1]Contribution from the Illinois Natural History Survey and from the Zoological Laboratories of the University of Illinois, No. 275.


A
DEVELOPMENTAL TOTAL = 2500
TEMP - DEGREES C.
DEVELOPMENTAL UNITS
B
DEVELOPMENTAL TOTAL = 2500
TEMPERATURE SUM = 2500 DEGREE HOURS
TEMP - DEGREES
DEVELOPMENTAL UNITS
29 EFFECTIVE

the mealworm pupa. The temperature summing curve is the reciprocal of the assumed time temperature curve which is an actual equilateral hyperbola. The Greek letter α is used for the zero of the hyperbola and for the corresponding point on the velocity curve because the point has only mathematical significance and is without biological meaning. When correctly drawn the velocity curve always makes an angle of 45° and thus velocity values are always equal to temperature values. It was, in fact, velocity values that were summed instead of temperature, for it is only insofar as velocity values are the exact equivalent of temperature values, that accurate results may be secured. The actual velocity curve for the development of the mealworm pupa at constant temperatures is a straight line between 18° and 29° C. only. In this short range temperature and velocity units are of equal value. Within these limits the constant for the curve which may be derived by multiplying time and temperature, is 2500. It has been found that variable temperatures are stimulating so that means of fluctuations between 18° and 29° in this case would give a smaller constant than non-fluctuating temperatures. Development is 1.02 to 1.08 times as rapid as under constant temperature experiments. Here we are concerned only with constant temperatures and the case is simplified. In Fig. 7 A, at 25° C., the velocity read from the curve is 12 units per hour. 2500 ÷ 12 is 208.33 hours, at the end of which period development will be complete.

Fig. 7 A and B. The relation between the actual velocity curve (A, solid line and points) and the curve assumed in summing temperatures (B, straight from 13° to 42°C.). The crosses and other symbols in A, represent the data of Krogh ('14), on the pupae of *Tenebrio molitor*. This is probably the most careful work yet done. It throws doubt on the suggestion that a portion of the velocity curve is *not* a straight line. For this straight line (18° to 29°) portion, the old law that time multiplied by temperature gives a constant holds good. Outside of these limits it does *not* hold good, and a day in our latitude, hardly passes in which one or the other of the limits is not exceeded. 2500 (hour-degree) developmental units complete the pupal stage. The curve (solid) represents number of units accomplished in one hour at the various temperatures. Taking 23°C., for example, the velocity as read from the curve is 10 units per hour. Dividing 2500 by 10 indicates that development can be completed in 250 hours. At 13 degrees, two developmental units are accomplished in one hour, and 1250 hours will be required to complete development. This temperature is the threshold which would be assumed in "summing temperatures;" on this assumption development would never be completed at 13°C. This point has a purely mathematical significance, and hence, the Greek letter α is used to designate it. In figure B, it will be noted that temperature above 13 and developmental units are of the same value, and have the same constant or total, so that it would be developmental units which were summed just as much as temperature.

Likewise, taking curve B, at 25° C., the effective temperature is 12°, with the total degree hours 2500 also, the velocity is 12 units per hour with the total 2500. Hence, it is only in case the velocity of development curve is straight as in B, that temperatures can be summed with the desired results. All known curves are similar to A and none like B. Developmental units may be summed with correct results when the curve is of the A type, or of the B type. A developmental unit in this case is the difference in amount of development between a given temperature, (between 18° and 27° C. only), and another temperature one degree higher. In this case it is 1/2500 of total development of a pupa. When applied to weather conditions, temperatures become means for hours, humidity varies and must be taken into account, air movement must be considered and the effect of variability determined. When this has been done the developmental unit becomes 'that fraction of total development produced by one degree of mean, medial, variable temperature, operating for one hour in conjunction with mean, medial, variable humidity and air movement, normal to the habitat of the species.'

Under conditions of variable temperature, the curve A may still be used. When temperature varies by rising slowly or falling slowly, as it does under ordinary weather conditions, the mean temperature for one hour may be used and the error will be very small if the velocity corresponding to this mean temperature, for the hour, is used. Thus, if the temperature for a given hour rose from 14° to 18° C., so as to give a mean of 16.5° C., for the hour, 4 units would have been covered. If the temperature rose from 18° to 22° C., giving a mean of 20° C for the next hour, 7 units of development would be accomplished. If the mean temperature for the third hour was 27° C., the 14 units of development would be accomplished. Adding the units covered by each of the three we get a total of 25 units accomplished in the three hours. 25/2500 or 1/100 of the development of the mealworm pupa would be accomplished. Thus, by summing the hourly units, (average velocity), corresponding to mean hourly temperatures, we can predict the approach of the completion of the pupal stage.[2]

Under actual weather conditions it is necessary to have a figure for the number of developmental units accomplished at each combination of temperature and humidity of common occurrence. Such values may be transcribed to correspond to the combinations occurring, and summed

[2]The curve and constants for variable temperature would be slightly different but this makes no change in principle.

to ascertain the time at which a given emergence may be expected. When these calculations have been made on the basis of average stock it is possible to estimate the effects of other factors, and to determine the variability of the stock used in experiments and correlate it with earlier or coincident weather conditions.

II. Variation in Physiological Condition and Response

Sanderson, '10, and Headlee, '14, have called attention to the difference between different generations of the same species in respect to responses. This fact, together with differences from year to year, has been brought out by a study of the codling moth and chinch bug under the auspices of the Illinois Natural History Survey, running over several years. The following are striking examples of variations, the causes of which are known and the experimental control of which is possible.

1. Codling Moth.

a. There may be as much as 20% difference in the length of pupal life from time to time under the same conditions of temperature and humidity, as calculated or observed, due to preceding rainfall, variation of temperature, etc.

b. The lengths of all stages vary with falling and rising temperatures, with the generation, and rainfall.

c. The threshold or point at which development begins to be perceptible, varies from season to season.

2. Chinch Bug.

a. Vitality of the stock taken from the field, as shown by abundance under the same conditions, varies from year to year.

b. The number of generations varies.

III. Methods with Special Reference to Time of Appearance of Stages

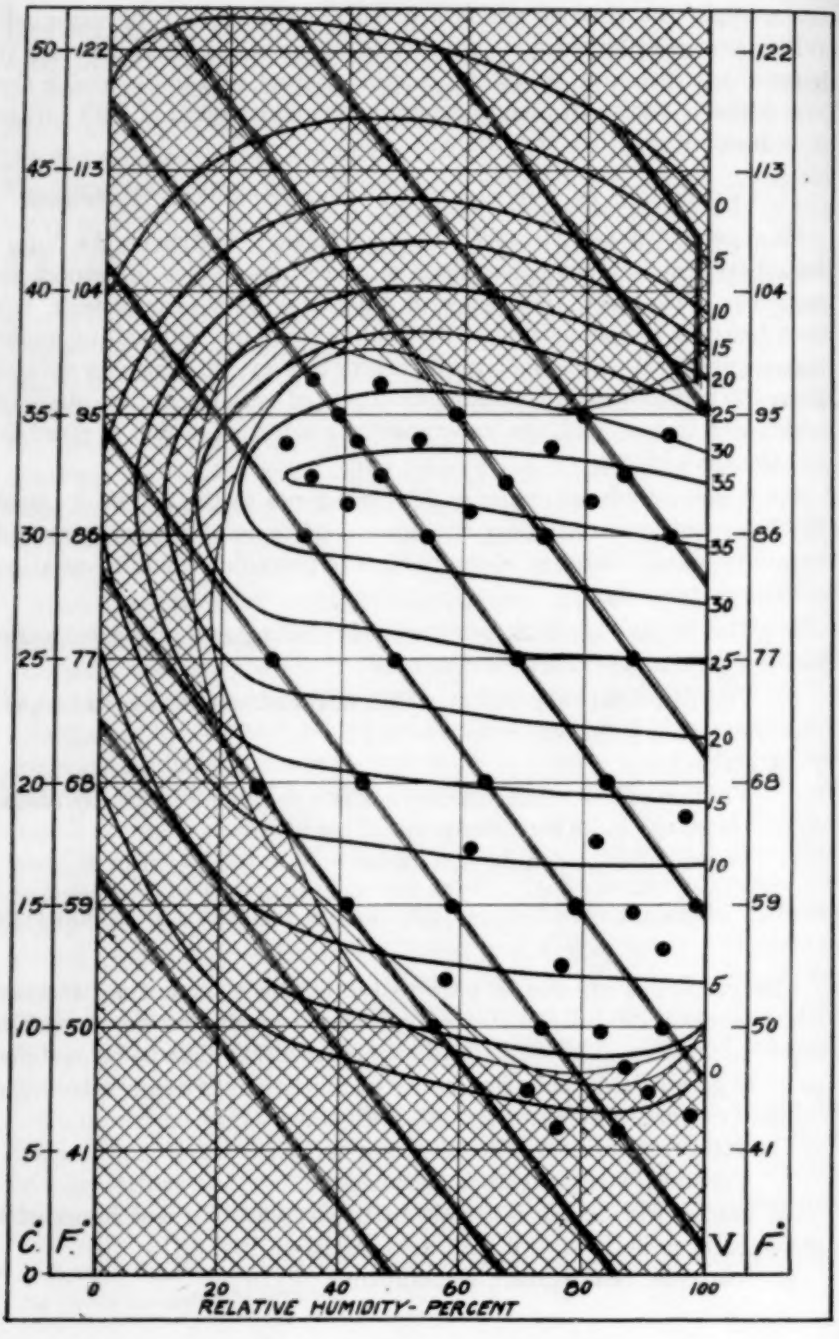
The variations are due in part to the effects of preceding weather, which necessitate full continuous weather records for the period of experimentation. The methods of experimentation have to be modified so as to give a fairly complete set of combinations of temperature and humidity on uniform materials. (See Fig. 8.)

The following series will usually need to be made:—

1. Constant Temperature Experiments.

At two to five degree intervals from 5° to 39° C., and humidities, arranged in series in accord with dots placed on Fig. 8.

2. Variable Temperature Experiments.


50 122
45 113
40 104
35 95
30 86
25 77
20 68
15 59
10 50
5 41
0
C°
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100
RELATIVE HUMIDITY- PERCENT
V
F°
122
113
104
95
86
77
68
59
50
41
0
5
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15
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a. With variations within medial temperature, (18° to 29°C; Fig. 7 A); humidities of 90%, 80%, 70%, and 60% at 18° C., etc., as suggested in Fig. 8.

b. With variations outside the medial temperatures, such as 20° to 40° C. at 100%, 60% and 30% (20° C.), and several other combinations to extend outside the limits of life for the species, (See Fig. 8), but within the limits of possible weather conditions as suggested in Fig. 8.

3. Under Weather Conditions.

Animal under out of door conditions in the experimental containers, and if possible, with air movement produced by wind.

Such a set of experiments requires 6,000–10,000 individuals in each life-history stage and several men to carry on the work. The experiments should be repeated during each of two or three years, if possible. If not, a one year or one generation running should be on the scale suggested with a smaller number of experiments in subsequent years or generations for comparison. Otherwise the difference in stock used will throw much irregularity into the results and greatly increase the difficulty, and error.

The results of such temperature and humidity experiments must be checked against three or more years of field study of length of stages.

IV. Equipment

To carry on experiments on the scale required, equipment of a type not yet on the market is essential. It would take a Carrier unit for each temperature and humidity, and cost $150,000 for cabinets alone. A plan by which a number of humidities can be supplied at each temperature is required. Control of light and air movement are essential also.

V. Methods Having Reference to Abundance

The continuous culture of species, which are important when abundant, is necessary, and the combinations of temperature and humidity

Fig. 8. The light area shows combinations of temperature and humidity under which constant temperature experiments are likely to yield development in the case of the common animals of temperate latitudes. The dark area shows condition under which constant temperature experiments are likely to fail either through death or failure to transform. The numbers 5, 10, 15, etc. in connection with the oblique lines are velocities of development under variable temperatures and indicate the combinations of temperature and humidity commonly tolerated for short periods of variation. The dots indicate combinations of temperature and humidity at which constant temperature experiments should be set up, and the lines along which temperature and humidity should be caused to vary in variable temperature experiments. Velocity outside the limits of constant temperature experiments must be ascertained by the study of variations into these conditions.

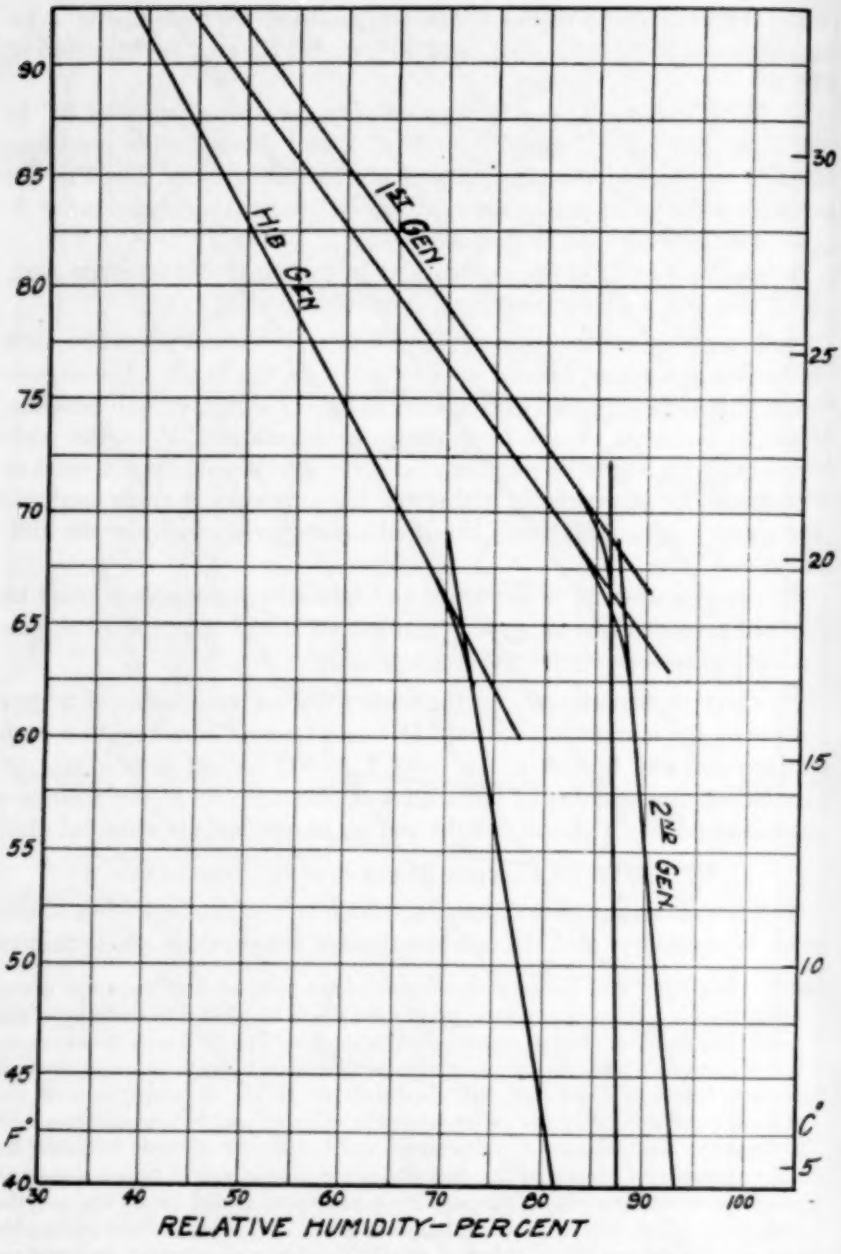

Fig. 9. Shows the average daily march of temperature and humidity as affecting a group of early spring insects (1), of midsummer insects (2), and late summer insects (3). Constant temperature experiments should be arranged on lower humidity with each higher temperature in accord with these lines.

just outlined are important in this work, though a somewhat smaller number of combinations may be used. Laboratories must be equipped for the control and measurement of light intensity and wavelength. Studies of the relations of egg laying to light, is a problem having important bearing upon abundance, (Isely & Ackerman, '24), which require intricate apparatus, and careful observation.

The chief value of all experiments is to determine the effects of various factors, which without such analysis are likely to be confused with others with which they are correlated.

V. Field Observation—Quantitative Collections

For more than thirty years quantitative study of plankton in both marine and fresh waters has been well organized and carried on with some continuity. Since 1908, bottom samplers have been used on the bottom fauna of the Danish waters for the purpose of determining the quantity of food for fish and other useful animals. For years past Dr. W. E. Allen of the *Scripps Institution* for *Oceanographic Research*, has taken daily plankton samples, together with observation on the conditions, from the pier at La Jolla (Vaughn '26), for the purpose of determining the relation between conditions and productivity, and for the purpose of making possible the use of some marine organisms as *indicators* of condition to obtain later on land and in the sea.

The collection of all animals on land should be carried on for the purpose of determining the quantity of organisms which *hinder production*, and of those animals which prey upon the plant feeders. Collections, including all animals that may be collected and preserved, should be made *continuously* and accompanied by continuous records of temperature, humidity, air movement, and light. Data thus acquired constitute the primary basis for interpreting the cause of quantitive increases, and predicting years of insect abundance. Experiments are however entirely essential to the proper interpretation of such field observations and thus the two go hand in hand. This means serious consideration of animal communities. Hitherto this has not been done. Primary consideration has been of species and individuals and not of aggregation. The loose use of community terminology is indicative of this fact. The study of abundance is primarily a community study and experimental work of the kind described has important relations to community problems. Both constitute pure science fields, forming an important background for economic entomology. The necessity for *continuity* of observation cannot however be over emphasized and the

use of hygrothermographs in all the larger weather stations is essential. Unfortunately their use has been discontinued in recent years by a number of stations.

VI. Facilities Necessary

The most desirable means of providing the facilities for experimental work here outlined, is by the endowment of a laboratory for research on insects similar, in scope, to the Thompson Institute for Plant Research. The results from such a foundation would undoubtedly be of great benefit to agriculture. There are, however, numerous problems that individuals with small amounts of equipment can undertake, but any plan to carry on extensive enough investigation to make possible the improvement of prediction of time of spraying, requires facilities not ordinarily available, and the undivided time of several men continuously over a considerable period of time, including the hibernation periods of the insects. *Continuity* is probably one of the most important essentials for such work.

The data acquired can in time be brought together in the form of a part of an Economic Zoologists Handbook similar to an engineer's handbook. Animals other than insects are important in the control of insects and insects present no new principles.

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Mr. B. B. Fulton: I should like to ask Dr. Shelford if the results of this work could ever be applied alone to insects like the codling moth to predict the spraying records.

Mr. V. E. Shelford: That is exactly what my unpublished paper was supposed to do. It hasn't been tried, and I want you members to try it.

Mr. B. B. Fulton: I wanted to know, when your data were complete, whether it would be possible.

Mr. V. E. Shelford: My material varied. I think it will work with

the Illinois climate but I don't know whether it will work elsewhere. If the curves are approximately the same throughout the codling moth range, I think that it either will work or can easily be adjusted so that it will.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The next paper is by N. E. McIndoo.

AN INSECT OLFACTOMETER

By N. E. MCINDOO, *Entomologist, Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture, Washington, D. C.*

(Withdrawn for publication in June issue)

MR. R. N. CHAPMAN: I should like to ask if in the event you had no attractant on one side and both sides acting as a control, would you then get the distribution of beetles on the two sides according to the law of probabilities?

MR. N. E. MCINDOO: They go through just about half and half. There is a little variation. If you have two sides equally alike, there might be half a degree difference, but if the two sides are not quite alike, there might be two or two and a half degrees difference. In those cases I allow about two and a half per cent.

This work is all preliminary. I am not putting it out as absolute fact yet.

MR. F. C. BISHOPP: For a good many years we have been groping about somewhat in the darkness in connection with the responses of insects. I think Dr. McIndoo is to be congratulated on developing here an apparatus which is a long step forward in the direction of getting a means of correlating and comparing information. I think this is really one of the best contributions we have listened to at this very splendid meeting of our Association.

MR. W. V. BALDUF: I would like to say in connection with the cucumber beetle, they have been observed in large numbers on wilted plants, particularly plants pulled up in the thinning-out process. It is commonly seen there that the beetles accumulate in considerable numbers on the underside and feed at those points. I have also suspected that after the epidermis is once punctured there is more odor of cucumber emanating therefrom. The wilted plant seems to have that peculiar odor to a larger extent than the green one.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The next is a paper by W. B. Herms.

AN ANALYSIS OF SOME OF CALIFORNIA'S MAJOR ENTOMOLOGICAL PROBLEMS

By W. B. Herms, *Entomologist, University of California Agricultural Experiment Station*

Abstract

Because of the great variety of crops grown commercially in California, the economic entomologist must specialize to a large degree in order best to serve. There is much waste and injury in the use of insecticides when a proper scientific basis for action is lacking. In this, both the farmer and the entomologist are often at fault. An unbiased investigation of the fundamental principles of insect control will in some instances at least, reveal astonishing discrepancies in our present methods of procedure. Intensive laboratory experiments coupled with carefully planned field investigations are essential.

Thus experiments with newly hatched codling moth larvae which attack both the apple and English walnut in California, indicate that the efficacy of lead arsenate in protecting apples in particular against side entrances and stings has been greatly overestimated. Greater attention to orchard and packing house sanitation is urged.

With what appears to be a gradual development of resistance of the black scale of oranges to hyrocyanic acid gas and the well known resistance of the citrus red spiders to the same gas, oil sprays are now being used quite extensively in the citrus areas of California. A strong tendency to use oil sprays against red spiders on prunes is evident in many parts. The use of oil sprays presents many difficult problems such as possible injury to the tree and discoloration of the fruit, but much trouble has already been obviated by the development of a quick breaking emulsion of highly refined lubricating oils.

The large amount of damage done by the garden centipede to asparagus and that of certain soil infesting nematodes has created a strong demand for soil fumigants. It has been found, however, that the damage to asparagus done by the garden centipede can be entirely overcome by proper flooding where that is possible. On the other hand, an effective soil fumigant is now available in the xanthates which are valuable when properly employed on account of the decomposition product, carbon disulfide.

Sugar beets, one of the pioneer crops of California, have been threatened for some years by a disease known as curly-top which is carried by a very small leafhopper. The control of this insect presents much difficulty on account of its migratory habits. Cotton is one of the newer crops of California but is already valued at over $10,000,000. To keep this crop free from the pests so prevalent in the South is one of our problems, and to prevent native insects from transferring their affections from wild vegetation to this valuable crop is another.

California beekeepers have long disagreed as to the nectar value of the California buckeye. It is now known that when severe droughts curtail the nectar possibilities of other plants and bees are compelled to use the buckeye alone, poisoning of the bees is pretty sure to follow, while mixed with nectar from other plants, that of the buckeye is harmless. Similar climatic peculiarities limit the use of top minnows (Gambusia) in anopheline mosquito control.

Great differences in topography within a short distance, likewise ocean and desert influences within a narrow range, greatly influence climate and make it dangerous to generalize in control recommendations.

Fruit, field and vegetable crops (only) of California for 1924 sustained an estimated loss of over $28,000,000, if the general average of losses due to insects holds as was estimated for 1922 by the State Department of Agriculture, namely, 6.7 per cent. This estimate is undoubtedly within the actual loss. The cost of insect control as related to these same crops is estimated at about $11,500,000, using 2.7 per cent of the total crop value as a basis. This approximation of cost is also calculated on State Department of Agriculture estimates for 1922. Both the estimated loss and the estimated cost of control are subject to gross error as is readily conceded. What the value of a crop might have been had its pests been held entirely in check is not easily determined and what would have happened had no pest control measures been employed is equally hard to determine. Perhaps, the remedy was applied just on general principles and the crop might have been better off without this disturbance. Cases might easily be cited to show that applications of sprays just on general principles, whether on trees or cows, without scientific foundation may be both unprofitable and unwise. One of our problems, not uncommon elsewhere, is to so help the grower that he may operate his farm with good judgment even in the use of pest control measures. Intelligent cooperation between the farmer and the entomologist is essential to success. It is not enough for the economic entomologist to say from the depths of an easy chair, "Here is the formula, take your spray pump and shoot on the dope, it will do the business." If it weren't for the stringent administration of the California "Economic Poison Act of 1921" and the increasing vigilance of our scientifically minded economic entomologists, California would soon become a paradise for the unscrupulous insecticide merchant.

In spite of the high degree of efficiency achieved in the field of insect pest control, there is still too much taken for granted in this field both by the farmer and by the entomologist. An unprejudiced investigation of the fundamental principles of insect control will in some instances, at least, reveal astonishing discrepancies in our present methods of procedure. It is quite natural for us to magnify practical orchard experiments because it is the orchard which must be protected against insect pests, but there is much to be gained through intensive laboratory experimentation. The experimental laboratory method can be safely urged even though it may not be popular in the field of economic entomology. Furthermore, a more careful study of crop management is urged since it is often possible, as all of us know, that the use of insecticides can be avoided and a more economical method may be devised

based on management, and in this procedure one may still be an economic entomologist. The great variety of crops to be found in California makes it difficult for any one person to be familiar with the management of all, hence the strong tendency toward specialization in the study of crop pests.

The apple crop of California for 1924 was valued at $8,991,000[1] and the damage done by insects is estimated at over $1,000,000 with more than $2,000,000 spent in control. Few, if any, insects have been so extensively studied as has the codling moth and heated discussions have raged for many years concerning its control by the use of arsenical sprays, yet much difference of opinion still exists as to results obtained. The recent work conducted in our laboratories by R. H. Smith[2] shows clearly that carefully controlled laboratory experiments with newly hatched codling moth larvae reveal many discrepancies not hitherto discovered in even the most carefully conducted orchard experiments. Smith's experiments indicate that the efficiency of lead arsenate in protecting apples against side entrances and stings has been greatly overestimated. Mist coverage is greatly inferior in protectiveness to the coarse overspray and film coverage. He also concludes that a loose covering of lead arsenate dust is far more effective in preventing injury than lead arsenate spray. Furthermore, after more than two years of orchard experimentation with arsenical sprays on apples, an investigation called forth because of dangerous arsenical residues due to overspraying, another of our workers (Lamiman) was forced to conclude that orchard and packing house sanitation were of prime importance in the control of codling moth. Intensive laboratory experiments together with carefully planned orchard investigations are both needed to secure satisfactory results.

The diabolical interest that the codling moth has taken in our English walnut crop valued at $9,030,000 for 1924, has created a situation that has already resulted in an abandonment of many acres of trees in certain localities. The chief difficulty in the control of this insect on walnuts is that while arsenical dust is effective, it cannot be applied economically due to the luxuriant foliage of the trees and the great overlapping of broods. Orchard sanitation and hand picking of infested nuts give promise of economic control.

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[1]California Crop Report 1924. U. S. Dept. of Agric. in cooperation with State of Calif. Dept. of Agric. Special Publication No. 55. (Sacramento, 1925), 39 pp.

[2]Smith, Ralph H. The efficacy of lead arsenate in controlling the codling moth *Carpocapsa pomonella* (Linn.), as indicated by studies with freshly hatched larvae. Hilgardia. (In press.)

Although apples are far from the top of the list of our leading crops, the amount of money spent in the control of apple pests, chiefly the codling moth, is exceeded only by the cost of pest control in the case of oranges, our second most valuable crop (hay being first). The 1924 California orange crop was valued at $40,320,000, the loss sustained by insects is close to $4,000,000, and the cost of pest control will run close to $4,500,000. This expense is largely traceable to fumigation in the control of scale insects, particularly the black scale (*Saissetia oleae*). That a degree of resistance to hydrocyanic acid gas has been developed on the part of scale insects seems apparent, with the result that a great interest has been created in the use of oil sprays which together with a large amount of dissatisfaction with lime sulfur against red spider (*Tetranychus* spp.) on prunes makes this (oil sprays) one of our outstanding projects.

It appears that little thought had been given prior to the use of oil, to the possible effect of sprays of any kind on the sugar content of prunes based on drying ratios. Attention to this matter grew out of the fact that oil sprays caused the beautiful bloom of the prunes to become blotched and this, in turn, caused attention to be given to the drying ratio and sugar content. Except for the effect on the drying ratio on which sugar content is based, this injury to the bloom does not matter so much in the case of dried prunes, but to the shipper of fancy blue plums this spotting is decidedly ruinous. Other types of oil or petroleum oil of higher refinement or combinations of oil with other chemicals must be used in order not to injure the bloom on the plum. Then again, oil sprays against red spider on lemons cause the fruit which is picked green, to color very slowly. Both this serious retardation in the coloring of lemons and the injury to the bloom on plums are being rapidly overcome.

The use of oil sprays so far as our citrus industry is concerned has another advantage in that it is valuable both against the gas-resistant black scale (*Saissetia oleae*) and the citrus red spider (*Paratetranychus pilosus*) which has always been rather strongly resistant to hydrocyanic acid gas. Oil sprays for red spiders seem destined to stay.

The high cost of the highly refined lubricating oils has retarded their general use but this difficulty has been largely overcome by a change in the type of emulsion. de Ong[3] found that by reducing the amount of calcium caseinate to .04 of one per cent of the oil used, a quick breaking

[3]deOng, E. R. and Knight, H. 1925. Emulsifying agents as an inhibiting factor in oil sprays. Jr. Econ. Ent., vol. 18, p. 424 (April, 1925).

emulsion was produced. A two per cent concentration of oil emulsified in this manner is as effective as the six per cent concentration of emulsion first used. Quick breaking emulsions are desirable since then the oil which is the active insecticide is immediately brought in contact with the insect instead of water or the casein solution.

Asparagus has rapidly grown to a place of importance among the vegetable crops of California. For 1924, the value of this crop is placed at $11,050,000, very nearly as valuable as our peach crop. The garden centipede, *Scutigerella immaculata* (Newport), is the only important pest affecting asparagus. The damage, however, is very great being estimated at one-fourth of the crop in infested areas,—naturally, one would turn to some form of soil treatment in the control of the centipede, but such treatment has so far been found prohibitive in cost. Winter flooding has solved the problem in a very satisfactory manner and fortunately nearly all of our asparagus is grown in the great delta region of the San Joaquin and Sacramento rivers where water is plentiful and cheap so that this method of control is readily employed.

Experiments by Wymore[4] on a large scale involving several hundred acres of asparagus indicated that where the ground was covered about six inches deep not quite 100 per cent control was secured even though the ground was covered for nearly four weeks, while where it was covered to a depth of a foot or more, in some places for only about two weeks, no garden centipedes reappeared during the following season. Flooding as a control can, however, be considered practical only where there is an abundance of cheap water and the fields are nearly level.

The presence of such soil infesting organisms as the garden centipede and nematodes emphasizes the need of investigating soil fumigants. While paradichlorobenzene gives excellent results as shown by Essig[5] in the control of the peach borer (*Aegeria opalescens* Hy. Edw.), the pear root aphis (*Eriosoma languinosa* Hartig) and the woolly apple aphis (*Eriosoma lanigera* Hausm.), it has its limitations when great acreages need to be treated in intensive fashion. Laboratory investigations and extensive field tests indicate that the xanthates may be very effective when properly employed. As is well known, the principal value of the xanthates[6] is in the decomposition product, carbon disulfide.

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[4]Wymore, F. H. 1924. The garden centipede, *Scutigerella immaculata* (Newport), a pest of economic importance in the West. Jr. Econ. Ent., vol. 17, p. 520.

[5]Essig, E. O. 1926. Paradichlorobenzene, a soil fumigant. Calif. Agr. Exp. Station Circular. (In press.)

[6]deOng, E. R. Potassium xanthate as a soil fumigant. Industrial and Eng. Chem. Vol. 18, No. 1, p. 52, Jan. 1926.

When used alone carbon disulfide is very unstable in the presence of air, and is explosive and must be emulsified when diluted with water. The xanthates are readily soluble in cold water and may be used alone, but are much more effective in an acid medium such as calcium phosphate ($CaHPO_4$). When thus neutralized the xanthates decompose at a rate which permits regulation according to the amount of acid salts added. This makes possible a quick fumigating action when first applied and a slow release of carbon disulfide over a period of days, thus making it particularly valuable in the destruction of soil infesting insects and nematodes in the resistant stage.

Both the experimental work on oils and xanthates together with nicotine and other chemicals indicate the very great value that arises from a knowledge of chemistry. The entomologist will find it well worth while to turn over one of his staff, entomologically trained, of course, to the chemistry department for a thorough grounding in chemistry. This plan pursued in the case of one of our Assistant Entomologists, E. R. deOng, has demonstrated the value of this procedure. Furthermore, I would urge a similar arrangement in the matter of plant physiology.

Sugar beets have long been an important crop in California, the estimated value for 1924 being $7,826,000, about which value the crop had the previous year, being considerably less in 1919 and 1920. The most obdurate enemy of this crop is the beet leafhopper (*Eutettix tenella* Baker), the vector of curly-top. This insect and its relation to the disease has been studied most assiduously by H. H. P. Severin and other workers for a good many years, but a practical method of control remains yet to be discovered, and the causal agent still remains unknown. The problem is considerably involved as even a brief analysis will prove. The beet leafhopper flies from its natural breeding grounds on the plains and foothills after the pasture vegetation becomes dry in the spring and often migrates long distances. Its host plants on the plains and foothills harbor curly-top so that 17 per cent in 1924 of the enormous hordes of beet leafhoppers in the spring were infective to weeds, particularly to varieties of beets among cultivated plants in the invaded districts. After the host plants in the cultivated areas become dry the return autumn flights to the plains and foothills occur, which are covered with green pasture vegetation in a normal season of rainfall. It is evident that the cultivated districts are practically free from beet leafhoppers during the winter and if beets are planted early (December to February inclusive), a marketable crop can usually be obtained in the

interior regions of California. Early planting, however, is dependent upon weather conditions. Control of the leafhoppers in isolated beet fields can be partially accomplished by the use of repeated dusting with nicotine dust, but owing to the margin of profit, is prohibitive. A factor of great importance in connection with the beet leafhopper and curly-top is that these insects carry the disease to certain other crops as field beans, spinach, peppers and other vegetables as indicated by field and laboratory investigations carried on by Dr. Severin. Should this relationship prove to be serious, efforts to control *Eutettix tenella* must be redoubled, since the development of disease-resistant sugar beets would still leave other crops unprotected and numerous weeds harboring the disease would also remain as a menace to cultivated susceptible crops. Biological control as applied to the beet leafhopper is now being seriously considered. The mass movements of the beet leafhoppers would offer a serious obstacle to the successful establishment of natural enemies providing a spring and autumn dispersal of the parasites does not occur in the natural breeding grounds.

Cotton is one of our newer crops, but is already valued at over $10,000,000 (1924). With the introduction of new crops, new problems quickly present themselves. The old established pests of other localities may be absent as in this case, but we wonder rather anxiously what native species of insect will transfer its attention from native wild vegetation to the newly established crop, a matter of common observation in every cotton growing country of the world. The Malvaceae are a notoriously favorable group for attack by native insects. For example, a considerable acreage of cotton was planted in newly cleared land in the vicinity of Bakersfield and shortly thereafter *Eleodes omissa borealis* Blaisd. quickly and wickedly transferred its affections from the wild vegetation to the newly introduced cotton. This incident affords a good reason why the native insect fauna should be continuously studied. In this matter, our Dr. E. C. Van Dyke is particularly interested and watchful.

The cotton leaf perforator, *Bucculatrix thurberiella*, is a most disturbing factor in the cotton growing areas of California. It is reported that a loss of about $2,000,000 has been suffered in the Imperial Valley due to this insect. Although much of the life history of the leaf perforator has been worked out, possible methods of control based on the winter habits of the insect not yet fully known remain to be developed.

California beekeepers have long disagreed as to the nectar value of the California buckeye, *Aesculus californica* Nuttall. Some insist that

bees are killed by feeding on the nectar from this plant and others are equally insistent that it is a valuable and safe source of nectar. These divergent opinions have been harmonized by our apiculturist, G. H. Vansell, who has shown that buckeye is seriously injurious to bees (wherever this plant is abundant) during seasons when a deficiency of top soil moisture exists or when for any other reason other plants fail to produce enough nectar to be more attractive to the hive bee than buckeye which is a deep rooted plant and consequently not so seriously affected by drought. Mixed with nectar from other plants, that of the buckeye appears to be harmless. Another interesting factor in this problem is the sap feeding bug, *Irbisia solani*, which migrates from grass when it becomes dry and attacks young twigs, leaves and blossom buds of the buckeye, from which droplets of sap exude at the punctures. These droplets are sought by bees and may play an important part in buckeye poisoning, a matter still to be determined.

During the seasons of 1916, 1917 and 1919, the writer made a malaria-mosquito survey of California which resulted in locating the principal malaria foci in the state and in the ultimate establishment of mosquito abatement districts in many of these localities. A demonstration district was organized and operated at Anderson in Shasta County during the season of 1920 under the direction of S. B. Freeborn with splendid success. A few seasons ago top minnows, *Gambusia affinis*, were introduced in a number of localities by the State Board of Health and where these can be maintained, mosquito control is excellent: however, the tendency has been to plant these minnows without following up the results, and in some instances, at least, an increase in malaria can be traced to an over dependence on the top minnow. The reason for such failures is to be found in the fact that our smaller streams, dredger ponds and the like dry up very largely during the dry season and are much swollen during the rainy season, both extremes being disastrous to the life of the top minnow.

There is much still to be learned about the flight activities of our anopheline mosquitoes. An invasion of hordes of anophelines into localities where control is being exercised creates a situation that is not altogether flattering to the man in charge of anti-mosquito operations, particularly in view of our contentions that anophelines do not fly far from their breeding places, which is true for the active breeding period but for California, at least, must be modified to exclude the two great annual flights, a spring flight in February and an autumn flight during late September and early October.

These flights are probably dispersal flights and advantageous to the species. What distance these flights cover, we do not know positively. Although there is always much solicitude concerning malaria infectivity during these flights, this is not justifiable except to a certain degree in the case of the autumn flight.

Time does not permit a consideration of problems presented by the ever present and seasonably destructive grasshoppers, cutworms, mealybugs and other crop pests nor is there time to consider the Argentine ant which is now widely distributed and common in California.

In the pursuit of exact information concerning insect behavior by means of the experimental laboratory method which is basic in checking up on our field experience, one of our chief problems is equipment for controlled humidity, temperature and light. A new world teeming with interest is waiting to be occupied by our younger entomologists who may be *prepared* to enter the same.

FOURTH VICE-PRESIDENT R. L. WEBSTER: The last paper on the program is by J. J. Davis.

THE VALUE OF A BOYS AND GIRLS INSECT COLLECTION CONTEST

By J. J. DAVIS, *Lafayette, Ind.*

(Paper not submitted for publication)

(At this point Acting President R. N. Chapman assumed the chair and the final business was transacted.)

Joint Meeting of the Entomological Society of America and the American Association of Economic Entomologists

Wednesday Afternoon, December 30, 1925

The Joint Meeting of the Entomological Society of America and the American Association of Economic Entomologists was called to order at two o'clock Wednesday afternoon, December 30, 1925, in the Pompeian Room of the Hotel Baltimore, by George A. Dean, President of the Entomological Society of America.

CHAIRMAN GEORGE A. DEAN: This, as the program states, is a joint session of the American Association of Economic Entomologists and the Entomological Society of America. We are to have a symposium on "Insect Parasitism."

The opening address will be "The Place of Parasitism in Insect Control," by Dr. L. O. Howard, Chief of the Bureau of Entomology, who for many years has been the leader in biological control of insects not only in this country but the entire world as far as that goes.

MR. L. O. HOWARD: "The Place of Parasitism in Insect Control," is the title on the program. I wrote a paper, and after I got through with my paper, I read the title, and it occurred to me that perhaps I had a different construction from the one in the mind of the Secretary, Mr. Metcalf, who originated this symposium, at least in part. It occurred to me after the paper was already prepared that he might have meant the place of parasitism in insect control in nature. I hadn't considered it from that point of view, so if I am right or if I am wrong, you are going to hear the same paper anyway; if I am wrong, this is my time and my way of apologizing. (Laughter).

THE PARASITE ELEMENT OF NATURAL CONTROL OF INJURIOUS INSECTS AND ITS CONTROL BY MAN

By L. O. HOWARD, *Chief, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

The paper summarizes the work in introducing parasites, points out some of the mistakes that have been made, and generalizes as to the principles involved in work of this kind. It has something to say about the expense involved in much of the previous work in this direction, showing that where there has been actual waste it has been due to ignorance or incompetence. Only the best trained experts should be allowed to take part in investigations leading up to international exchanges. In case of serious loss from introduced pests, studies of the parasites in the native

home should be begun at once, and no expenditure consistent with rigidly scientific methods should be begrudged.

When the economic entomologist confronts an emergency problem it is his duty to bring measurable relief as speedily as possible. At the same time he must begin studies looking forward to natural and therefore comparatively costless control. No one at all broadly familiar with the insect complex can doubt the importance of the insect enemies of insects. So important does their work appear to me that I am inclined to rank it the main factor in the preservation of the so-called "balance of nature." Surely it is one which demands our most careful attention.

The food necessities of the rapidly growing human population of the world make it necessary for us to grow enormous and increasing food crops. As we do this we make equally enormous and increasing opportunities for the multiplication of certain insects. And does it not occur to you that this in turn should give the insect enemies of those certain insects such unprecedented food supplies that they should increase beyond all previous experience and become of the very greatest help to us in the fight to avoid starvation?

All this seems logical, and in the long run it will happen in just that way. But we want to hasten the process. In the case of crop enemies brought in from another part of the world we cannot wait for the relatively slow adaptation of native parasites to the new host. We must bring to the new country the parasitic forms already accustomed to and adapted (in the course of centuries) to the crop pest accidentally imported.

This is the theory on which so much work has already been done, and it is safe to say that, failing some startling discovery which is likely to be made at any time, such work is still in its infancy. We have seen some strikingly successful results, and some workers have been overencouraged. Many instances will occur to you, in which, carried away by the wonderful success of certain introductions into California and Hawaii in the closing years of the last century, highly intelligent men, like the late Elwood Cooper of California, for example, have made claims which today seem preposterous and which even then were discounted by the trained entomologists.

But even all the trained entomologists did not see clearly. The great master, David Sharp of England, when I met him one day, in 1902, in the British Museum, told me that in his opinion the economic entomologists should abandon every other kind of work and devote

themselves exclusively to the parasites and predators. Even Doctor Sharp's brilliant son-in-law, Frederick Muir, in spite of his remarkable successes in Hawaii, would not have made so sweeping a statement.

While it is true that the introductions of *Novius cardinalis* into California and other parts of the world have been followed by almost immediate results of enormous value, and while it is true that some of the Hawaiian work has given speedy and striking results, and that both of these instances did much to start and encourage the prosecution of the biological control idea, it is almost unfortunate that these results were so speedy and so perfect, since it has encouraged many people to expect equally speedy and perfect results in all cases. In fact, many people are disappointed and discouraged when work of this kind is not successful almost immediately.

As a matter of fact, complete control by parasites and predators is rarely gained by such work. The success of the Australian Novius is almost unique. Only the success of the sugar cane leaf-hopper parasite in Hawaii and that of the parasites of the sugar cane borer in the same islands approach it in simplicity, efficiency and speed. Immediately following these comes the introduction of *Prospaltella berlesei* from America into Italy where after a few years it virtually controlled the mulberry scale. And at the present time there is reason to hope that *Aphelinus mali* will approximate this record in the control of the woolly apple aphis in New Zealand and parts of Australia, although the same insect in France, Italy and South Africa seems to be less efficient.

As opposed to these speedy beneficial results, we must remember the rapidly growing list, not of failures, but of parasitic insects of slow establishment and of only partial control of the crop pest. Many differing conditions in different countries operate favorably or unfavorably on introduced species, and these species themselves vary in their susceptibility to different conditions.

With many species of parasites the normal environment is complicated. Years ago, in discussing the spread of land species by the agency of man and the liability of an introduced species to accommodate itself to a foreign territory, I formulated the idea that "It is upon the degree of simplicity of its life—the degree of simplicity of its normal environment as a whole—that the capacity of a species for transportation and acclimatization, even in a parallel life zone, depends." I had in mind when I wrote this only injurious insects, but it holds equally well for parasites. Now, as it happens, with very many important

parasites life is not simple—it is vastly complicated—and it results that an almost complete knowledge of its normal environment must be gained before we can expect successful introduction and acclimatization.

The question has been proposed to me by Doctor Metcalf as to what proportion of an appropriation should be used for parasite work. This question necessitates a complicated and somewhat devious reply. A great deal of money has been spent uselessly; and again, good results have been gained with little money. The introduction of *Prospaltella berlesei* into Italy cost the Italian government nothing. It was sent over by our Federal Bureau at Washington. The introduction of *Aphelinus mali* into France, Italy, New Zealand, Australia, several countries in South America, and South Africa, cost these countries nothing; all were sent there directly or indirectly from Washington, with the exception of the South African introduction, which was made by a South African student at Cornell University.

The Hawaiian work has been very expensive in actual outlay. The Sugar Planters' Association must have spent some hundreds of thousands of dollars in this productive work. But this expenditure has been very well worth while, since the continuation of profitable cane growing on the islands has been the direct result.

But no part of the earth which does not have the very simple native fauna and flora of Hawaii, which does not have its equable tropical or subtropical climate, and which does not consist of islands rather limited in size, can expect with any degree of certainty to achieve results at all closely approaching these. And even from Hawaii many expensive expeditions have been fruitless.

California has spent in years past large sums of money with no appreciable results; not only that, but in at least one instance has hurt herself by introducing and liberating a parasite which proved to be hyper-parasitic upon a beneficial primary introduced and established at a much later date. In fact, insect control in California was greatly hampered for nearly twenty years by a general reliance on the expected success of much work which was carried on by unscientific enthusiasts. It may as well be placed on record that all California parasite importation work as it was then carried on would have been stopped by Secretary of Agriculture James Wilson, under the Federal law of March 3, 1905, had not Harry S. Smith, a highly trained expert of the Bureau of Entomology, taken charge of the work for the State under Prof. A. J. Cook, Commissioner of Horticulture.

The complications of work of this kind on a large continental area

in the temperate zone have been shown vividly in the work carried on and now under way in the Bureau of Entomology, and the Bureau has been able to devote as much money to it as its promised success from time to time seemed to warrant. It is probable that the men engaged in its prosecution have been as well fitted as any to be found. Some of them have grown up with the work as it has grown. It will not be necessary to attempt to estimate the sum the Bureau has already spent in this direction in toto, but our experience over many years led us to spend $10,000 on alfalfa weevil parasites in 1923, and last year $15,000 on corn borer parasites, $2,700 on Mexican bean beetle parasites, $28,000 on Japanese beetle parasites, and $50,000 on gipsy moth and brown-tail moth parasites. These sums include the salaries and expenses of traveling experts and foreign assistants and laboratory expenses abroad as well as similar expenses at the receiving end in the United States. In the case of the corn borer parasite work, something over $3,000 of the $15,000 was spent last year in the home end of the work.

Down to the present time nothing spectacular has resulted from the prolonged efforts of the Bureau. Very many beneficial insects have been imported and have become acclimatized, and the present excellent condition of the New England woodlands as a whole must be attributed in large measure to the work of the Bureau importations. But it must be remembered that these importations have been coming in since 1905 (except for the five years of war time) and that we are still continuing. This fact in itself shows that the problem is a big one with very many ramifications, and it indicates further that immediate results are not to be expected, except under certain conditions, in a country like ours. Congressional committees and the Budget Bureau say to us, about our various parasite projects, "You say 'the work is promising,' but how about definite results?" It is difficult to make them understand our unwillingness to make definite promises; but the subject undoubtedly greatly interests these hard-headed, practical men.

The number of trained entomologists is increasing so rapidly almost all over the world that it is becoming an inexpensive matter to secure the introduction of promising parasites, on a comparatively small scale, by correspondence—almost at the cost of postage. It is a sample of the mutually helpful feeling that exists to an extraordinary degree among entomologists—an early instance of the true international spirit that is coming. Practically all of the later shipments

of Novius have been from California rather than from Australia, and the great work that this insect has done in Egypt, Portugal and many other countries was made easy by the courtesy of California.

In a thoughtful and important paper just published in Nos. 6 and 7 of the *Revue de Zoologie Agricole* for 1925, B. Trouvelot has listed the principal attempts made in sending beneficial insects from one country to another from 1873, when Riley and Planchon introduced *Tyroglyphus phylloxerae* into France from the United States, down to the present year. Thirty-four such efforts are listed, of which seventeen were made at a cost so slight as to be inappreciable, while I estimate that the others cost in the neighborhood of one hundred and fifty thousand dollars. Of the thirty-four attempts listed, more than half (eighteen) have not as yet shown beneficial results, and the majority of these will never show such results.

In this list there is no mention of many efforts, costing large sums of money, which have been absolutely fruitless, notably the world travel for many years of one of the California agents; the journey of two South African experts to Brazil to investigate one of the announced finds of the Californian; circumnavigation of the glove by an Australian expert, and, I fear, some of the more recent work of traveling agents of California, Hawaii, Italy and the Bureau of Entomology at Washington.

Wherever there is actual waste of money in parasite work it must usually be laid to ignorance or incompetence. Only the best trained experts must be allowed to take part. It becomes a matter of danger to the country in other hands. It is for this fact that the U. S. Bureau of Entomology, with its large corps of men who have made such work their especial study, wishes to control in a way all such importation work for the United States; and it is, in fact, so empowered by law. It is for this reason that we have charged ourselves with the establishment of the parasites of the European earwig in the Northwest although the City of Portland is apparently willing and able to undertake the work.

There are many things which will be brought out in this symposium, and many more which might be discussed to great advantage, but I can touch on only a few, although I could talk on the general subject all day long for several days.

Passing over the well known subject of hyperparasitism, we may well devote a few words to superparasitism or coparasitism. The possible introduction of too many parasites—that is, too many kinds of parasites—has been seriously considered by workers for a number

of years. Beginning with the strenuous controversy between Berlese and Silvestri concerning the parasites and predators of *Aulacaspis pentagona*, and strengthened by the studies of Pemberton and Willard of the parasites of the Mediterranean fruit-fly in Hawaii, the different aspects of the subject have been more or less theoretically considered by several writers, notably by Thompson, by Wardle and Buckle, and Trouvelot in his recent papers.

A case in point is just now under consideration. It is proposed to bring to Bermuda from Hawaii the parasites of the Mediterranean fruit-fly. Shall the four species now working in Hawaii all be sent to Bermuda, or shall only one—*Opius humilis*—be sent? In the work of Pemberton and Willard referred to, the conclusion was reached that the four parasites working together do not destroy as many fruit-fly larvae as the Opius working alone. The Opius larva is destroyed by two of the others when working in the same fruit; while alone it is more prolific than the others. But the Hawaiian entomologists do not agree perfectly. Some believe one way, while others think that the more species of parasites introduced the nearer we come to actual control, thus backing up the stand made by Silvestri in his long controversy with Berlese. Mr. Willard, I believe, is of the opinion that the Opius should be sent on first and tried out.

Among the many things that persons in charge of such operations must remember is the normal food of the adults of the parasitic forms. We have during the past few years been learning more and more of the habits of adult parasitic Hymenoptera of feeding by suction at the holes made by the ovipositor in the body of the host insect. It seems in fact to be a wide-spread habit and in itself is probably responsible for a considerable mortality among the hosts. But with the Scoliid wasps, whose work against underground Scarabaeid and Cetoniid larvae seems so important, we must study the botanical food of the adults—the flowers they visit by preference, and we must be sure of the abundance of at least closely allied plants in the countries into which these parasites are introduced. This also holds, although perhaps it is not so important, with the Tachinids and the Dexiids. Is it not a prerequisite with some of these that they visit the flowers of umbelliferous or other plants before pairing or before oviposition?

The expense at the receiving end must not be stinted, and the most expert ingenuity and care must be exercised. In many cases, where the parasitic supply has come from some foreign country without cost, all necessary expenditures must be made by the receiving entomolo-

gists. In no case will it suffice to turn the imported material loose, even under the most apparently favorable conditions. The original supply must be multiplied by breeding, and experimental loosings must be made.

Again and again valuable importations have been lost through carelessness, lack of forethought. One very promising experimental sending was lost to an European country, for example, for the reason that the man in charge went away on vacation, leaving the work in untrained hands. And on another occasion an expert went half way around the world, and after infinite care and trouble brought back to his home country a good supply of healthy, living parasites of an important, imported pest, only to lose the results of this costly and laborious journey through inadequate provision and care at the home end.

Great ingenuity has been exercised in the multiplication of parasites at the importing end. The development of the potato-sprout idea for the rapid rearing of mealybugs to serve as food for Cryptolaemus in confinement in California laboratories is a marked example, and other novel and effective methods have been worked out at Melrose Highlands, at Riverton and in France. And a better and most varied technique will be developed as time goes on.

The latest attempt to sum up the complications and the difficulties in parasite introduction has been made by Dr. B. Trouvelot of Doctor Marchal's laboratory, in a paper to which we have already referred. He brings out in clear form many of the points that had already occurred to most of us engaged in active work of this kind and summarizes in a concise way the factors that should be comparatively studied both in the importing and exporting countries. These he thinks are, (1) The climate (humidity or drought of certain months) modifying both the activities of the species and their rapidity of multiplication; (2) The distribution of plants, both wild and cultivated; (3) The fauna, its composition and distribution; (4) The cultural methods followed (the size of the fields, character of the soil, period of harvest, and the amount of cultivation); (5) Finally a factor dependent upon all of the others; the life history of the host, its local and regional distribution and its vulnerability.

After general consideration has been given to the points specified above, Trouvelot again considers other points which must be studied before a choice of parasites can be gained. These may be listed as follows:

(1) Synchronism of the life round between the parasite and the host.

(2) Parasitic activity.
(3) Possibility of superparasitism and coparasitism.
(4) Tendency to hyperparasitism.
(5) Variations of the parasitic activity according to the climate.
(6) Possibilities of hybridization with related species belonging to the importing country.
(7) Power of dispersal of the parasites compared with that of the host.

We have already hinted at the popular appeal which parasite work always carries. Last September there were two striking instances of this. There was a conference of State experiment station directors and agricultural officials in Ohio, Michigan and southern Ontario to review the corn borer situation. At Bono, Ohio, on the 29th, the visitors saw two of the European parasites of the cornborer in action under laboratory conditions, and the unanimous opinion was that this exhibition was a revelation of a phase of entomology of which they had but the haziest conception. All were enthusiastic.

The next day this party went to Chatham, Ontario, and visited the corn borer parasite laboratory there. In one cage they saw thousands of fertilized females of *Exeristes roborator*, and this cage was carried to a near-by field in which every stalk was infested by the borer. The parasites were liberated in full view of the whole party of more than one hundred persons. Although it was a cold, raw, windy, overcast day, the parasites began at once to search for larvae hidden in the stalks and to lay their eggs through the tough epidermis of the stalks. This delighted the observers. Some of them, incredulous that the parasites could locate the borer from the outside, dissected the stalks, only to find that in all cases the parasite had unerringly deposited its eggs on the hidden caterpillars. At the conclusion of this demonstration one prominent educator, the Dean of the School of Agriculture in a great corn State, is reported to have remarked that the demonstration had given him an entirely new conception of the significance of economic entomology.

Three years ago I published a paper entitled "A Side Line on the Importation of Insect Parasites of Injurious Insects from One Country to Another" (Proceedings of the National Academy of Sciences, June, 1922), in which I called attention to the extraordinary way in which some of the imported gipsy moth parasites have taken to native hosts. One of the most extraordinary of these parasites for its general adaptability is the Tachinid, *Compsilura concinnata*. Since its introduction

in 1906 it has attacked 92 species of native insects, and it has established itself in New England in such a way as to act as automatically as any native species.

Lately a significant thing has occurred which intensifies the value of this species, and in fact has a bearing upon all such importations. The European satin moth appeared in New England recently. It multiplied in a most remarkable way, and there was apparently no attack upon it by native Tachinids. But the European Compsilura had become acclimated, and at once attacked the new European invader. Webber and Schaffner have shown in Bulletin 1363 of the U. S. Department of Agriculture, now going through the press, that in certain last-stage-larva collections a parasitism of 78 per cent by this species has been noticed and that in their aggregate of all collections parasitism averages 50 per cent.

The latest experiment of an international character and one which offers many possibilities and comparatively few complications is the effort made by the government of Fiji to find effective parasites for the so-called levuana caterpillar which damages the leaves of the cocoa palm to such an extent as to cause great alarm. Several men have been engaged in this work, notably Mr. John D. Tothill of Canada (trained partly, by the way, in the Gipsy Moth Parasite Laboratory of the Bureau of Entomology), Mr. A. M. Lea of Adelaide, Australia, Mr. Hubert W. Simmonds and Mr. C. T. McNamara. Here it was impossible to find immediately the native home of the pest, but expeditions were sent to the Malay Archipelago and the parasites of allied species were studied with the result that, after one or two unsuccessful attempts were made, three enemies of the allied *Artona catoxantha* were secured and bid fair to become established. One of them, a Tachinid (*Pychomyia remota*) immediately began to attack the levuana caterpillar "as if it had been attacking it from time immemorial" (Tothill *in lit.*). Then there was a Clerid beetle (*Callimerus arcuper*) which in both larval and adult stages attacked the pests with enthusiasm. There was also a single female of a species of Mesostenus, from which a rearing has been made. In this work the question is arising as to the relative value of the Tachinid and the Braconid and as to the possibilities of bad results from the rivalry of the two species.

I have several times urged the wisdom of a large-scale attempt to import from abroad all parasitic and predatory insects which may be of help to us in our efforts to control imported pests. We could probably add to our fauna some hundreds of species which would be of

positive assistance to us. We are really spreading out into such a scheme in many directions, and are learning, in some cases through mistakes and wasted effort, how it can be done most efficiently and economically.

It is true that some admirable results have been obtained in the old, more or less haphazard way, and we have nothing but praise for Koebele and his Novius work and for the Hawaiian explorers. But it is now very evident that, in order thoroughly to exhaust the possibilities of success in the majority of cases, especially where continental areas are concerned, detailed studies, which may in general be called ecological (for want of a better term), must be made both in the importing and exporting regions.

All sorts of conditions will arise, some of which may be grouped as follows:

(a) Where the insect and its parasites are well known in its home country and where competent entomologists are anxious to assist;

(b) Where the original home of the pest is not known;

(c) Where the original home is known, but its parasites and their interrelations are not known;

(d) When there is a close morphological relative to the injurious form in some other country, whose parasites may be expected to take readily to the species aimed at or whose mode of life is so similar as to excite an oviposition impulse from its parasites.

In 1911, in recounting the original plan for the introduction of the parasites of the gipsy moth and the brown-tail moth, I wrote (Bulletin 91, Bureau of Entomology, pp. 13, 14)—

"It seemed to the writer that by attempting to reproduce in New England as nearly as possible the entire natural environment of the gipsy moth and the brown-tail moth in their native homes, similar conditions of comparative scarcity could surely be reached, and this view he still holds with enthusiasm."

In this statement, I think today that I well expressed the fundamental idea, and that the study of "the entire natural environment" is essential in most of these problems. This is only another way of expressing the need for extended ecological work.

A final word in regard to the too optimistic predictions of enthusiasts: We have seen in California the unfortunate results of too much optimism. We have seen also, within the past few years, the sudden discovery of the descendants of importations of parasites which had been here unnoticed but gradually increasing for from twenty to twenty-

five years; which means that, not only must we not be over-confident, but also that we must not be too easily discouraged. I like to remember, in regard to the first point, the concluding words of Froggatt after his tour around the world in 1907 and 1908, in his report on his expedition:

"Let the whole question be judged on its results. Allow that one or two experiments have shown perfect results *** that can be no reason why the parasite cure alone should be forced upon any one. Its admirers should be perfectly honest.*** The wisest can never be sure of the results of any experiment ***. Those at work for its [economic entomology's] far reaching interests could do it no greater harm than by misleading or unproved statements."

As to the place of parasitism in plans for insect control:

It should receive consideration in all cases of imported pests just as soon as it is decided that extermination is likely to be impossible. Studies of the parasites in the native home of the pest should be begun at once, and, in the case of serious loss, no expenditure consistent with rigidly scientific methods should be begrudged. Work of this kind is in its infancy, and its possibilities are great. (Applause).

CHAIRMAN GEORGE A. DEAN: Some of the most fundamental studies made on the influence of temperature or climate on insect life have been the investigations of Dr. V. E. Shelford, and I feel we are very fortunate to have him present the next paper on "The Relation of the Abundance of Parasites to Weather Conditions." (Applause)

MR. V. E. SHELFORD: I accepted the invitation to speak on this subject only after much insistence on the part of Dr. Metcalf, and why I did it, as nearly as I can figure out, was because I knew nothing about the subject and thought possibly I could tell you how I would go about trying to find out something about it.

I had some work on parasites that I thought might lend itself to this purpose, but it proved to be inadequate, so I have drawn upon the admirable observation and experiments of others and will attempt to show you some of the things that I have developed in this connection on other forms.

THE RELATION OF ABUNDANCE OF PARASITES TO WEATHER CONDITIONS[1]

By V. E. SHELFORD

ABSTRACT

Parasites are governed by the same laws as other insects. Abundance is influenced by weather but no definite general rules as to the relative effect upon the host and the parasite can be laid down. The test of abundance is abundance itself as shown by continuous quantitative collections correlated with complete weather records. Experiments are necessary to indicate which of several correlated factors are controlling each particular case.

I. INTRODUCTION

One often thinks of parasites as governed by different and more intricate laws or rules than other organisms. This is not, however, especially true of insects parasitic on other insects. In the main they are similar to insects feeding in the bodies of plants, or of dead animals. As to causes and factors covering abundance little appears to be known and it is the purpose of this paper to indicate some of the general types of methods which will probably prove helpful in the investigation of the question.

Granting sufficient numbers of individuals of the one or several host species, the abundance of a parasite is controlled primarily by the following:

1. Survival during adverse periods or periods of inactivity.
2. Rate and duration of development of new generations.
3. Activities controlling fertilization, egg laying, migration from host to host, etc.

II. SURVIVAL

There is nearly always more or less mortality during periods of inactivity. The number of individual parasites present after a period of hibernation, aestivation or cessation of activity is determined by or is markedly affected by weather and climate. The survival of the parasite is of interest in relation to the survival of the host. In this regard, evidently no definite rule can be laid down as to conditions suitable for the survival of parasite and host during rest periods. Weese ('24) who studied the large orb weaving spider (*Epeira gibberosa* Hentz) and its egg parasite (*Arachnophaga picea* Riley), during hibernation, makes the following statement: "It was evident that the hymenopterous insect parasitic on the eggs of this species, (*Arachnophaga picea* Riley) was able to reach maturity and to emerge under much more varied conditions

[1]Contribution from the Zoological Laboratory of the University of Illinois, No. 276.

than those favorable for the development and emergence of the spiders."

Likewise H. M. Hefley working under Weese's direction on (*Winthemia 4-pustulata* Fab.) a tachnid fly parasitic on the tomato worm, found that the host was much more sensitive to a large amount of moisture than the parasite. Unparasitized host larvae suffered from fungus, while the parasites emerged from fungusized host larvae. Dry soil was detrimental to both.

The grain aphis parasite (*Lysiphlebus tritici*) passes the winter only in the pupal stage (Glenn '09); all larvae are killed when the host is killed by cold weather. The host (*Toxoptera graminum*) passes the cold winters in the egg stage, thus reducing the hazards and probably giving the host advantage. The chinch bug egg parasite hibernates probably as a pupa in an egg (not common in autumn) or as an adult which would again be of advantage to the host which hibernates in numbers in the adult stage. Many other cases could be cited showing that in one case there are indications of advantage to the parasite and in another to the host. No definite rule can probably be laid down.

III. Rate and Duration of Development of New Generations

The number of parasites surviving an adverse period are the basis upon which all increments must be built. Abundance of parasites in a given season granting an average number of survivors from a preceding season is governed by;—

1. Rate of development to maturity (the length of time between generations).
2. Duration of reproductive life.
3. Rate of reproduction during reproductive life.

These rates and durations are influenced by weather. Here again the number of parasites is of especial interest in comparison with the abundance of the host, and it is the relative effect of weather conditions upon the two which must be sought. In considering the effects of weather factors all attempts at direct application[2] of weather data must be abandoned. Chief reliance must be placed upon the behavior of the organisms in question under conditions which may be regarded as standard. Temperature and humidity must be considered together because they vary continuously and reciprocally. Temperature is most generally important in controlling rates of progress in temperate latitudes but air humidity is its constant accompaniment. Organisms are

[2]Direct application is understood to mean the summing of mean temperature above an arbitrary starting point, etc.

not inured to constant condition and the rate of development is different under constant and variable temperatures, usually more rapid under variation.

Developmental units may be established. They represent fractions of the whole developmental process or period.

1. The developmental unit is the difference in amount of development taking place in one hour at a given medial temperature and at another medial temperature one degree higher as shown by the time to complete the stage. Under weather conditions it is the effect of one degree, mean medial variable temperature operating for one hour in conjunction with mean medial varying humidity and the air movement normal to the habitat of that stage of the life history.

2. Medial temperature is that range of temperature within which the increase in development is directly proportional to the rise in temperature. The velocity of development curve is a straight line within the medial range. Medial humidity is the humidity which usually accompanies medial temperature in the optimum climate for the species.

3. Velocity of development is the number of developmental units per hour. Relative velocity is the reciprocal of time to complete a definite process.

4. The threshold of development is that intensity or amount of any factor immediately above which development begins to be perceptible in amount.

5. The developmental total is the sum of developmental units at the time of the completion of a stage or life history.

The work of Headlee, Glenn and others on the grain aphis (*Toxoptera graminum* Rodeni) and its parasite (*Lysiphlebus tritici* Ashm.) make possible a comparison of the life relations of these two species so as to illustrate the principles outlined above. The curves (Fig. 10 and Fig. 11) are not however presumably correct and the developmental, totals, thresholds, etc., are only approximate. It is possible to determine the relative rate of development from curves of reciprocals of time under constant temperature or variations within limited ranges. Thus in Fig. 11 the curves of the host and parasite are drawn from Headlee's data as best they could be though the curve of the parasite is adapted to a single point in the medial temperature limits. It does not purport to be more than approximate but is suitable for illustrating the method. The lower the threshold the more rapid is development at any point above it, hence a rate of development varies inversely with α. The

steeper the curve the more rapid is development hence $\frac{\text{Tan } \theta}{\alpha}$ is the product of the two and their mean effect is $\sqrt{\frac{\text{Tan } \theta}{\alpha}}$. An inspection of Fig. 10 shows that the host develops faster within both ranges of temperature approximated by the dotted lines which give rough expression to the curve.

Fig. 10 shows the velocity curves in units per hour for three aspects of the life of the grain aphis as the host and Lysiphlebus as its parasite.

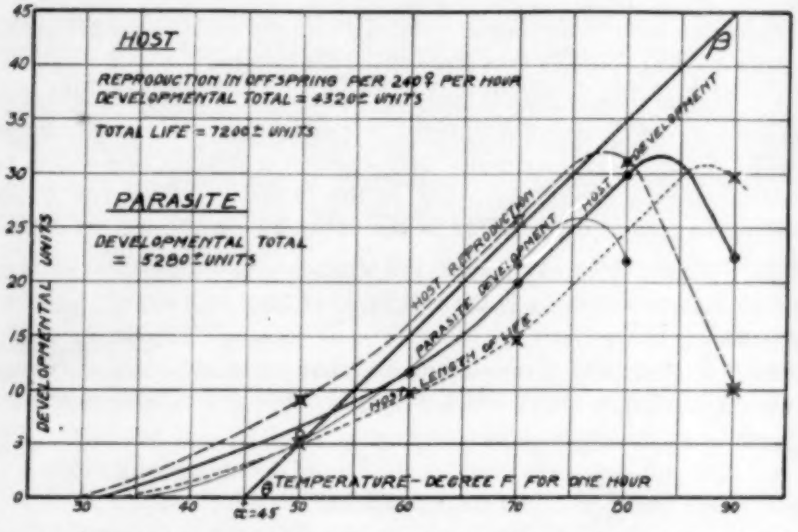

Fig. 10. The velocity of development curves of the grain aphis and its parasite after Headlee ('14). The circles indicate his data. The curves are 2400 times the reciprocals of time. Any point read from one of these curves on a particular temperature divided into 2400 gives the time required to complete a stage. The basis on which these curves are drawn is evidently not in accord with the characteristics of organisms. The method is however useful in estimating the relative rate on the basis of the value of α and the tangent of the angle θ as shown in the figures. Both approximations show that the rate of development is highest in the host. Between 30° and 62°F. the host velocity is 0.134 and the parasite 0.125 while between 62° and 70°F., the host is 0.168, the parasite 0.1549, the host being the faster.

It will be noted that the curves rise in a concave curve from the threshhold, then rise in a straight line through a few degrees (medial temperatures) and then turn downward. This form for the curves could not be ascertained in detail from the data of Headlee or of Glenn but

they were given the general form characteristic of such curves. The curves for the host in particular are straight for only a very short temperature interval. The straight line portion is well indicated by Dr. Headlee's constant temperature experiments. The thresholds were determined chiefly by Glenn during the outbreak of 1907–08. The rate of development of the host under ordinary variable temperatures is on the

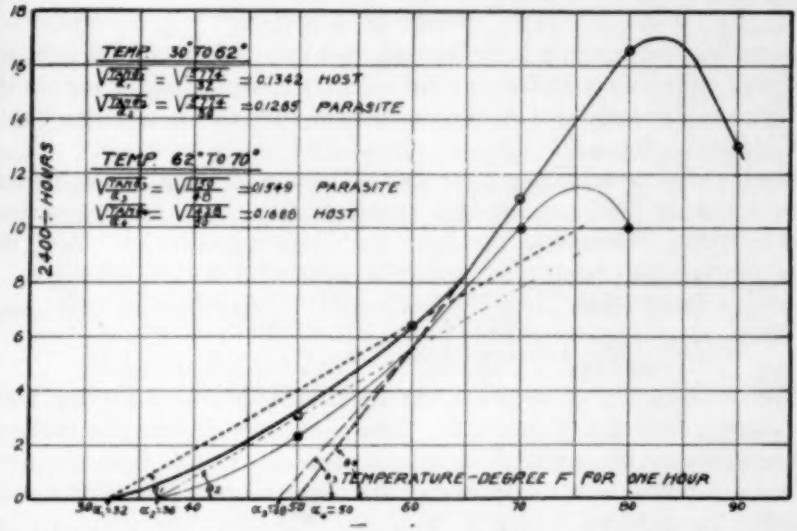

Fig. 11. The data of Headlee covering rate of reproduction and length of life as well as rate of devlopment for the host and parasite. Drawn with reference to their different natural constants and in accord with the idea of a constant sum total for metabolism; the thresholds are estimated from the observations of Glenn. The height of these curves may be read off on the developmental unit scale and divided into the constant to give time for completion of the process in question at a particular temperature. The difference in length of developmental periods is brought out here by the difference in constants. The developmental units do not differ greatly for the different organisms or stages at the same temperature. The β line shows the velocity that would be assumed in summing temperature.

whole faster than the parasite; the velocity is high for the host above 75° F while it is much lower for the parasite. The threshold for the host is 32° while that of the parasite is 36°. The developmental total of the host is 4320 units while that of the parasite is 5280 and the units are of about the same numerical value. At a mean temperature of 68° (variation within the medial range) a parasite would develop in 264 hours; a host would develop, in 240 hours. While the parasite was developing a host female would have produced 26.4 individuals. The parasite would

ordinarily sting 22 aphids during two days following its emergence (Hunter '09) when the total produced by one host female would be 31.2 individuals, thus being 9 individuals ahead of the parasite. It alone, could then never exterminate the host. It is easy to see how important a little delay in the progress of one species may be in determining the abundance of either a little later.

IV. Controlling Activities

Attention has recently been drawn to the importance of faint light in conjunction with certain temperatures in controlling the egg laying of the codling moth. Isely and Ackerman believe that this may control the abundance of the moth.

Some parasitic insects are similar. Glenn states that Lysiphlebus does not sting the grain aphis in cloudy weather but remains inactive and in hiding, meanwhile the aphis continues reproduction. McCulloch, on the other hand, finds that the parasite of the chinch bug egg, lays eggs at all times of the day or night in either light or darkness.

V. Indispensable Observations

The final test of abundance and its causes, is *abundance* itself as *correlated* with weather *conditions*. This means continuous observation of parasites and other insects by means of weekly or daily quantitative collections throughout many years. All other animals should so far as possible be included in the collections. This involves a procedure similar to that in common use in the study of aquatic organisms. Some species will serve as indicators of the abundance of other important species. While such observations overshadow experiments in importance, experiments are still necessary to determine which of several correlated weather factors are in control in each case. With a century of observation, most problems might be illuminated, but experiments may readily make ten years work equally valuable.

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CHAIRMAN GEORGE A. DEAN: I am sure we all regret that the next speaker who is on the program has been prevented from being with us. As a matter of fact, I think it is the first time Mr. Burgess has missed a meeting of the American Association of Economic Entomologists in something like twenty years. Fortunately, he has sent his paper on "The Present Status of Control of the Gipsy and Brown-tail Moths by means of Parasites," which will be read by the Secretary of the American Association of Economic Entomologists, Mr. Collins.

Mr. Collins read Mr. A. F. Burgess' paper. (Applause)

THE PRESENT STATUS OF THE CONTROL OF THE GIPSY MOTH AND THE BROWN-TAIL MOTH BY MEANS OF PARASITES

By A. F. BURGESS, *United States Department of Agriculture, Bureau of Entomology, Melrose Highlands, Mass.*

ABSTRACT

This paper deals with the results of the introduction of the parasites of the gipsy moth, *Porthetria dispar*, and brown-tail moth, *Euproctis chrysorrhoea*, during the past 20 years, and indicates that this work has been enormously beneficial. A number of the parasites have, apparently, reached their maximum and during the past two years a sharp decrease in parasitism has been noticed. In several sections of the infested area this has been followed by rapid increase in the abundance of the gipsy moth and just at present the work is passing through a critical stage, with no reliable information as to whether the gipsy moth or its enemies will gain permanent control. An enormous amount of scientific data have been secured and further efforts are being made to introduce other parasites that attack the gipsy moth.

About 20 years elapsed after the introduction of the gipsy moth into Massachusetts in 1869 before it became such a pest as to cause serious damage. During the period in which the extermination of the insect was being attempted by the Massachusetts State Board of Agriculture, that is, from 1890 to 1900, experimental work was carried on to determine whether or not it was being attacked by native natural enemies. In spite of the fact that at various times large colonies of the insect were found, the number destroyed by natural enemies was practically negligible. There is perhaps no better illustration of the introduction of a foreign pest without its enemies and its establishment in a country where no important enemies exist than the case of the gipsy moth.

During the period from 1900 to 1906, when the moth increased in such numbers as to become a veritable scourge, natural enemies were conspicuous by their absence. Up to 1900 no effort was made by the State of Massachusetts to study the natural enemies of the insect in foreign countries or to import them because the object of the work was to exterminate the gipsy moth, and it was felt that natural enemies would be destroyed by this process.

When the project was discontinued in 1900 the prejudice against work on the gipsy moth was so great that no effort was made to study and import natural enemies as a precautionary measure. It happened, therefore, when foreign work was begun by Doctor L. O. Howard in 1905, that the gipsy moth occurred in enormous numbers in the eastern part of Massachusetts. Thousands of acres of woodland continued to be stripped annually and the insect spread until all the New England States became infested. So far as having an abundant host was concerned, conditions were ideal for parasite introduction.

Another condition favorable to this work, and one that usually does not occur in such projects, was that the life history and habits of the host in this country had been studied extensively, the foreign literature had been carefully reviewed, and the facts recorded in an excellent work on the gipsy moth by Forbush and Fernald published in 1896.

Naturally, when the problem of securing natural enemies was taken up, it was assumed that much aid could be obtained from entomologists in the countries where the insect normally occurred, but experience proved that little definite information was available aside from what had already been published and these data were far from complete. Whole-hearted support and cooperation were secured from European and Japanese entomologists by Doctor Howard, but, unfortunately, very few of them had had an opportunity to make special studies of the parasites of this pest. The situation required that means be taken immediately to introduce parasites to assist in curbing the ravages of the gipsy moth and the brown-tail moth, and at the same time that precautions be adopted to exclude all secondary parasites.

Shipments were made from Europe during the first few years by European entomologists. Many species were received but great difficulty arose in handling them because of lack of knowledge of their habits and behavior, and it was necessary to undertake an intensive study of each species before they could be managed to the best advantage. To add to the troubles connected with this work, it developed that most of the material sent included webs, caterpillars, or cocoons of the brown-tail

moth and the difficulties of handling this poisonous insect were very serious.

It was at first expected that the results of parasite introduction would be apparent in the field in about five years, but at the close of that period no diminution of the damage caused by the gipsy moth was apparent, nor was much difference noted for 10 years after the beginning of parasite introduction. It should be said that there is no single species of parasite that controls the gipsy moth anywhere. With an insect of this type, which is attacked by several species of natural enemies and is not kept under uniform control by them in its native home, the strongest possible sequence of enemies is required to make any appreciable impression on it in a new country where the environment is favorable. For this reason a continuous attempt has been made to bring to this country all of the parasites that attack this insect. The fact that some of the valuable species do not occur in all countries where the gipsy moth is found, encouraged the belief that by assembling all the species possible the chances of success in controlling the insect would be increased.

Whatever may be the merits of the theory of the control of an introduced host by one major parasite, its value under field conditions requires further demonstration. At any rate, the relation of the parasites of the gipsy moth to their host is such as to give little promise of success by following this method.

The foreign collector would indeed be very courageous to discard all parasites that he might obtain and attempt to export exclusively the one which he conceived to be the most important. It frequently happens that some of the most effective parasites occur during some years in very limited numbers and an attempt to export a particular species might lead to failure to establish any species for many years. Furthermore, the necessity of giving the people who are suffering losses from an insect pest some measure of relief makes it imperative to do everything that gives reasonable promise of being helpful.

In spite of the fact that much information was available concerning the gipsy moth before parasite introduction was begun, many more important details have since been learned and our knowledge of the parasites themselves has increased enormously each year.

In a short paper such as this, few details can be given. It may suffice to state that up to the present time over 60 species of parasites of the gipsy moth and the brown-tail moth, including predacious beetles, have been imported from Europe and Japan. Of this number 16 species

have become established in New England. One-half of these have not become very abundant and are probably of slight importance.

The species that were well established and had become quite abundant in the field by 1914 were *Calosoma sycophanta* L., a predacious beetle which attacks the larvae and pupae; *Compsilura concinnata* Meig., a tachinid parasite of the larvae; and *Anastatus bifasciatus* Fonsc., an encyrtid egg parasite. In 1916 *Schedius kuvanae* How., another encyrtid egg parasite; *Blepharipa scutellata* R. D., a tachinid which attacks the larvae; and *Apanteles melanoscelus* Ratz., a braconid attacking the larvae, were found in considerable numbers in the field. Colonization of *Apanteles vitripennis* Hal., *Parasetigena segregata* Rond., and several multi-brooded tachinids have been made as a result of more recent European work, but their permanent establishment has not been demonstrated.

The gipsy moth laboratory at Melrose Highlands, Mass., has not only carried through the biological work that was necessary and determined the best methods of handling the parasites introduced, but has colonized them in the field and kept definite check-up records to determine the results of such colonization.

Beginning in 1915, the gipsy moth began to show signs of reduction in the oldest infested area, that is, the area of defoliation began to decrease gradually. In the areas which became infested later and which lie beyond the section mentioned, decrease in defoliation was not apparent until two or three years later. This was not all due to the increase of parasites. The reduction of favored food of the insect and non-hatch of the egg clusters were in part responsible. The prevalence of the wilt disease in some sections caused heavy reduction in the caterpillar population. This decrease continued with more or less regularity until 1924, when only a small number of localized areas were defoliated.

Hand suppression measures in the cities and towns, such as destroying the egg clusters by treatment with creosote and spraying the foliage with arsenate of lead, gave satisfactory results and prevented defoliation in the residential sections.

During these years the average parasitism by all species combined has gradually increased, the maximum having been reached in 1923. In 1925 there was light defoliation except in the Cape Cod section of Massachusetts where over 40,000 acres of forest growth was from partially to completely stripped. The records of the gipsy moth laboratory indicate a marked decrease in parasitism this year throughout the entire area, the greatest being in the Cape district, and the number of egg

clusters has increased somewhat throughout the territory, there being an unusually heavy deposit on the Cape.

The summer of 1924 showed the lightest gipsy moth infestation in the last twenty years, and the average percentage of parasitism was highest in 1923. Apparently conditions are beginning to swing in the other direction. What will happen in the next few years it is impossible to forecast. There is nothing definite upon which to make an accurate prediction. Will defoliated areas develop in other parts of the infested territory as they have on Cape Cod this summer, or will the gipsy moth fail to increase in sufficient numbers and no stripping result? It is hoped that the latter condition will prevail, but there is no certainty that it will be so.

This is the present status of the parasite work on the gipsy moth so far as density of infestation is concerned. The western spread of the insect has been checked by the effective field work done in the Barrier Zone in New England and the eastern part of New York and in the infested area in New Jersey. The sequence of parasitism on the brown-tail moth is rather more effective than on the gipsy moth and this insect occurs in destructive numbers only in limited areas. Briefly, this covers the conditions in New England.

Although a considerable number of species of parasites have been introduced and colonized successfully, it is believed that no effort should be spared to secure all the species that may be of assistance on the problem. Men from our own laboratory have worked in European countries during the past four years and also in Japan. This work is to be continued. The species that are easiest to collect and transport have already been secured. Several important species are very difficult to handle and a special study of their habits, number of broods, hosts, etc., is necessary before they can be managed intelligently. This is the problem that concerns the foreign work.

Too often the public is led to believe from popular articles that the importation of parasites will give speedy results. The idea looks feasible and its accomplishment appears easy. In operation it is beset with many unforseen difficulties.

Parasite introduction should be given more attention, but to make possible quicker and better results, more knowledge is necessary concerning both hosts and parasites; in other words fewer theories and more facts. This field has great possibilities if properly developed.

CHAIRMAN GEORGE A. DEAN: Those of us who personally know Professor Harry Smith and have had an opportunity of hearing him speak, on looking over the immense data that he has accumulated on parasitism, certainly regret that he is not here to present his contribution to this interesting symposium. Fortunately again, however, we have his paper, and it will be presented by Dr. William B. Herms, of the University of California. (Applause)

MR. W. B. HERMS: Mr. Chairman and Members: I wish to express to you Harry Smith's regret in not being able to be present today. He was in my office two or three days before I left for this meeting and expressed very great regret that he could not come.

THE PRESENT STATUS OF BIOLOGICAL CONTROL WORK IN CALIFORNIA

By HARRY S. SMITH, *University of California, Citrus Experiment Station, Riverside, California*

ABSTRACT

Biological control is discussed from two angles;, one, that of the public attitude toward it; the other, its present condition from the economic standpoint.

Because of the spectacular results of the introduction of Vedalia, the Australian ladybird, in the early days of California horticulture, the general public was inclined to favor this method of control to the exclusion of all others. This is no longer the case and while the work is generously supported both by scientific institutions and by growers organizations, it is very properly looked upon as only one arm of the defense against insects injurious to agriculture.

The numerical status of the cottony cushion scale is kept below the danger line in an almost perfect way by the work of *Vedalia cardinalis* and *Cryptochaetum monophlebi*. The contrary is true of the black scale which, although attacked by several parasites and predators, maintains a high level of abundance and is still the most important pest of citrus in the state. The attempt to find effective natural enemies of this pest is being continued. The red scale has been studied in the orient during the past 18 months and new natural enemies have been located there.

Mealybug control by the production and distribution of quantities of the ladybird Cryptolaemus has been eminently satisfactory, and costs of this operation have been reduced from those of the preceding season.

The writer has taken the liberty of changing the title assigned to him to the above, substituting "biological control" for "parasite" since, from an economic viewpoint, it is difficult to separate the two. The subject may be discussed from two angles, one the status of the work with regard to the attitude of the agricultural public toward it, the other its status from the economic standpoint.

It might not be worth while to discuss the former, were it not for the fact that in the early days of entomological development in California

this state, through the activity of well meaning but poorly informed persons, gained a reputation of favoring biological control to the exclusion of all other methods. This reputation has been somewhat difficult to live down.

Interest in this type of entomological work in California has always been keen, undoubtedly due to the fact that it was here, and well within the memory of many citizens of this state, that the first great successful project in biological control was carried out. The attitude of the leaders in agriculture has undergone a decided change during the last fifteen years. There is certainly no longer the danger, as was once the case, that parasite work will be supported at the expense of other means of control. The best informed growers now recognize that the biological method is not applicable to all their pest-control problems. Their attitude in the main is that the work should be developed to the fullest extent practicable but it is recognized that until otherwise demonstrated they must rely upon the so-called artificial measures for the handling of the greater part of their insect problems. This is in contrast to the situation in California twenty-five to thirty years ago, when the opinion prevailed that any insect pest could be controlled by the introduction of *its parasite*. The following quotation from a publication by one of the early advocates of what was then called the "bug vs. bug" method illustrates the extreme view held by some at that time:

"It has been demonstrated that so far as experience goes every pest has a natural enemy and all that we have to do is to find out the native home of a pest, go there and find the natural enemy, transport it and distribute it in our orchards to destroy the pest. This is the natural way. Any other remedy is expensive, has to be repeated, is unsuccessful and idiotic."

This was not the attitude of entomologists, so far as I am aware, but was the prevalent idea among certain people who were led by the old State Board of Horticulture. While their intolerant attitude toward those who were unwilling to go as far as they did was anything but commendable, we should not perhaps criticise them too severely for their enthusiasm. The outcome of the Vedalia introduction, following the threatened destruction of the citrus industry by the cottony cushion scale, was so spectacular, so dramatic, that the effect on the general public is easily understood, and it is not surprising that they were swept off their feet. The unfortunate thing about it all was that they drew general conclusions from this single experience which were so sweeping that there was, in their opinion, no place for such "idiotic" methods as

spraying and fumigation, with the result that progress in these valuable methods was greatly hindered. All this is now past history, and the enthusiasm of the public for biological control is now tempered by a far better knowledge of its limitations. Support for biological control work is generously accorded both by scientific institutions and growers' organizations but nowhere will one find that belief in the biological method to the exclusion of all others as was once the case. It is considered to be a valuable arm of defense against the ravages of destructive insects, but no longer the only one.

Cottony Cushion Scale

From an economic standpoint the control of this scale is practically perfect. Rarely it becomes rather abundart on isolated plants, particularly ornamentals, but almost invariably the Vedalia soon puts in an appearance and cleans it up. There is no question but that its natural enemies are the controlling factor. This has been thoroughly demonstrated during the past decade. Occasionally, growers have been persuaded by ignorant spray salesmen to treat their citrus trees with arsenical sprays. Under such circumstances, if the trees are slightly infested with Icerya, a severe outbreak is likely to occur. Evidently the poisoning of the egg sacs of the scale is destructive to the Vedalia, with the result that the check to the scale's increase is eliminated. I have seen orchards, under these conditions, where an almost unbelievable amount of damage has occurred, the lower leaves of the trees being covered with crystallized honeydew one-eighth of an inch thick, the twigs dying and the trees so severely injured that several years elapsed before they recovered their vigor. It requires only a few experiences of this kind to convince one of the protective value of this ladybird to citrus orchards.

The dipterous endoparasite, *Cryptochaetum monophlebi*, also plays an important part in the control of this pest. Its work is not so conspicuous, but often it is more effective than the Vedalia. This seems to be particularly true on young citrus trees and on certain ornamentals.

Black Scale

A great deal of attention has been and is being given to biological control in connection with this most important of citrus pests.

The status of the ladybird, *Rhizobius ventralis*, introduced by Koebele about three decades ago, has not changed greatly since the early days of its introduction. It is firmly established throughout the citrus sections of the state and elsewhere, becoming extremely abundant at times and

doing effective work, but almost always this occurs where orchards have been greatly neglected as to pest control and very serious damage has been done. Citrus growers of the better class never permit their orchards to get into the condition which seems most favorable for the active propagation of this ladybird. Under conditions suitable to Rhizobius, it reproduces with great rapidity. In an olive grove in Los Angeles County which had been permitted to become severely infested with black scale, Rhizobius became so abundant that entomologists interested in biological control had no difficulty in collecting many millions for experimental purposes, simply by beating the trees and collecting the ladybirds in sheets during the cool of the morning. In this grove, however, the damage done before the clean up by the ladybird was very severe and the owner would have been far better off to have adopted the regulation control measures. There is no reason to doubt that the same thing would occur in citrus groves if fumigation and spraying were omitted, but such a policy would be disasterous from an economic standpoint. In cases where artificial measures have not been adopted, Rhizobius will become abundant and do quite effective work, but it is unable to maintain the high standard of orchard cleanliness which is demanded by the best growers, even in the coastal areas, where it seems to thrive most.

What has been said regarding Rhizobius applies in a general way to *Scutellista cyanea*, the parasite introduced from South Africa in 1902, by Howard, Lounsbury and Craw. It is thoroughly established wherever the black scale occurs, and destroys a very appreciable percentage of the eggs of its host, but in spite of this there are always enough eggs escaping its attack to thoroughly re-infest the tree. Its enemies, mainly predatory mites and secondary parasites, together with the lack of correlation between its life history and that of its host, are sufficient to render it ineffective so far as practical results are concerned. The situation may be summed up by saying that Rhizobius and Scutellista destroy great numbers of the black scale, but even this is insufficient to check the ravages of this pest.

The status of *Aphycus lounsburyi* Howard, the internal parasite introduced in 1919 is about as follows:

It is believed to be the most effective natural enemy of the black scale in California at the present time, in spite of the unfortunate set back it received through the attack of secondary parasites. It occurs throughout the range of the black scale, at least in the southern part of the state, and is generally abundant, particularly along the coast. The necessity of

proper correlation between the life-history of a parasite and its host is strikingly illustrated in *Aphycus lounsburyi*. Owing to the short period required for its development it must of necessity go through several generations per year. It is capable of developing only on the later stages of its host. Over a large part of its range the black scale has only a single generation per year and this precludes the development of Aphycus in general from July to the following spring, during which period the black scale is too young to serve as host for the parasite. The result is that during this season the parasite becomes reduced almost to the point of extinction. It is able to maintain itself under these conditions because of the fact that there is a relatively small amount of off-hatch scale on young citrus trees, particularly grapefruit and on ornamentals, but its increase is so greatly checked by this lack of correlation that it is able to accomplish very little, practically speaking. In considerable areas directly along the coast the life-history of the black scale is quite different. Here all stages may be found at almost any season, so that Aphycus is able to develop without interruption. The parasite did remarkable work in these districts during the first two years after its introduction, and there seemed to be good reason to believe that an effective natural enemy for this scale in the coastal districts had been found. Gradually, however, the secondary parasite, *Quaylea whittieri*, which up to that time had maintained itself on Scutellista, began to increase and in time became sufficiently abundant to check effectually the good work of Aphycus. However, while this parasite, because of the attacks of secondaries, has not come up to earlier expectations, it has proven to be of much value indirectly. The "uneven hatch" condition of the black scale such as is found along the coast, while favorable to biological control, is unfavorable to artificial control for the reason that fumigation is not effective against the older scales. Where the hatch is even, as in the interior sections, fumigation can be timed so as to catch practically all the scales in the younger stages. This has not been possible along the coast, and for this reason more frequent fumigations have been required. The presence of Aphycus has tended to destroy the off-hatch scales, thus making it possible to get much more effective control by fumigation. Practical fumigators and growers are of the opinion that the parasite has been of very great value because of this lessening of the frequency of fumigation.

There are several other parasites of the black scale in California, the most important of which are *Coccophagus lecanii* and *C. lunulatus*. But even with this theoretically excellent combination of natural en-

emies, the black scale still maintains first rank among the insect pests of citrus in this state. Millions of dollars are spent annually for scale control in California, more than half of which is chargeable to this pest. The feeling is general that, in view of this heavy expense, the possibilities for biological control should be thoroughly tried out. Therefore, this is one of the main projects at the Citrus Experiment Station, and considerable effort is being directed toward further exploration work in the hope of finding something which will aid in reducing this expense.

For the past four years a parasite laboratory has been maintained at Capetown, South Africa, in charge of E. W. Rust. Frequent shipments of parasitized scale have been made, and several species of parasites have been reared from this material, and those which appeared to be of value have been colonized.

Two of these, *Coccophagus modestus* Silv. and *C. trifasciatus* Comp. have been recovered in the open one year after liberation, and seem therefore to have become established. They have not yet given any indication of becoming abundant but it is perhaps too early to draw any conclusions as to what their status will be ultimately. It is the intention to extend the search to other continents and to continue it until there is a successful outcome or until the field is exhausted.

Red and Purple Scales

Aside from the work done by Quayle[1] the question of biological control of red and purple scales has not received much attention. A project is now under way having as its aim a more detailed study of the matter. Generally speaking it may be said that neither of these scales is heavily parasitized. The most important parasite of the red scale is *Aphelinus chrysomphali* Mercet; that of the purple scale is *Aspidiotiphagus citrinus* Craw. As a general rule the parasitism by these species is negligible, but in localities where fumigation is not regularly practiced they have destroyed as high as 40 per cent of their hosts. As in the case of the black scale, these checks, in addition to the ladybirds which prey upon the scale, are not sufficient to keep the pests at a numerical status which would be below the danger line.

For the past eighteen months Dr. F. Silvestri has been carrying on work in the orient having as its object the discovery of additional natural enemies of the red scale. A complete report on this work will be issued in the near future and for the purposes of this article reference to it will be

[1]Calif. Agri. Exp. Sta. Bull. 214.

brief. Dr. Silvestri found on the red scale in China, in addition to the cosmopolitan *Aphelinus chrysomphali* and the oriental parasite *Comperiella bifasciata* Howard, a species of *Casca* which appears to be of value. Considerable difficulty was experienced in transporting the parasites to California alive because of their extreme delicacy. Sufficient numbers were received to make possible the necessary life-history studies, and a colony of several hundred was placed in an infested orchard at Tustin, Orange County, California. Field recoveries have not yet been made from this colony. Shortly after the shipment of this material by Dr. Silvestri the civil war broke out in China which necessitated his leaving China and no further material of this parasite was received. An effort was made to propagate this parasite at Riverside but the colonies gradually dwindled and the parasites finally disappeared. Dr. Silvestri also rediscovered the *Casca chinensis* described by Dr. Howard many years ago as a parasite of *Chrysomphalus aurantii*, but colonies were not obtainable at the time of his visit. In addition to the colonization of Casca and Comperiella, several species of Coccinellidae were received and are now being propagated for distribution. Of these *Chilocorus kuwanae* Silv. is established in the orchards in Santa Barbara County.

Because of the expiration of Dr. Silvestri's leave of absence from the Italian Government the oriental work in connection with the red scale must be discontinued for present, but it is hoped that it may be followed up sometime in the future, when political conditions in China become more settled.

Citrus Feeding Mealybugs

Biological control for these pests has developed along two quite distinct lines; one, the introduction and establishment of exotic entomophagous insects which prey upon them; the other the quantity propagation and distribution of predatory insects for the purpose of reducing the mealybug population to relatively harmless numbers.

The introduction of the ladybird, *Cryptolaemus montrouzieri*, by Koebele from Australia in 1895 is well known, and this insect has maintained itself in the state ever since its original introduction. Since then no exotic species became established until 1915 when the internal parasite of *Pseudococcus citri*, *Leptomastidea abnormis* (Girault), was successfully established from colonies received from Sicily. This parasite is now abundant wherever the common mealybug is found in California and has undoubtedly played a part in the great reduction in abundance of its host, so noticeable in recent years. In 1922 the lady-

bird, *Scymnus binaevatus*, was successfully introduced from Capetown, South Africa. This ladybird spread rapidly and is now common throughout southern California, where it seems to have a preference for the citrophilus mealybug, *P. gahani* Green, the most important of the mealybugs feeding on citrus. It does excellent work, although it is inconspicuous because of its size and color and its secretive habits. Recently the ladybird, *Exochomous flavipes*, has been introduced from South Africa and has become established, but whether permanently or not is yet to be determined. It is a general feeder but shows a preference for mealybugs. There are numerous native, or supposedly native, species of insects which prey upon mealybugs, most important among these being several species of lacewings and the predaceous fly, *Leucopis bella*.

The writer reported last year[2] on the control of mealybugs through the production of Crytolaemus by local insectaries in the infested districts. This work has been continued during the season just past, with equally satisfactory results. The citrophilus mealybug which, it seems certain, would have proved to be a serious pest, has been kept under commercial control by this method. While it has continued to spread rapidly, now occupying nearly 30,000 acres of orchards as compared with approximately 20,000 last year, prompt liberations of quantities of Cryptolaemus have prevented it from becoming unduly numerous in any locality. Costs of production are slightly less than last year, due to improvements largely in the way of labor reduction. Cost of production of Cryptolaemus was $8.16 per 1000 this season as opposed to $12.07 per 1000 last year.

It is rather difficult, owing to the nature of the problem, to determine with minute accuracy just how great are the savings due to the use of this method. Losses on four ten-acre groves which were not treated last year, averaged $1000.00 per acre. In every case where sufficient material for liberation has been available, damage has been reduced to practically nothing. The extremely rapid spread of the mealybug has made it difficult for the insectaries to keep production up to the needs of the situation, consequently there has been occasional injury on the periphery of the infestation, but I know of no case where the proper application of this method has failed to bring about entirely satisfactory results.

At the present time an experiment is being carried on in northern California to determine whether or not this method can be used in the control of the grape mealybug, *Pseudococcus maritimus* Erh., which

[2]Jour. Econ. Ent. Vol. 18, pp. 147–152.

has been doing increasing damage to grapes, particularly in the San Joaquin and Sacramento Valleys. One or two native species of ladybirds occasionally become abundant enough to check the pest and it is thought that there is a possibility of propagating these in quantity thus assuring their presence in the vineyards in sufficient numbers to maintain an effective control. The greatest obstacles in the way seem to be the fact that infestations are very spotted, making the colonization more difficult, and control of the argentine ant apparently will be more expensive than in citrus orchards. It seems well worth while, however, to give the method a trial. The work is being financed by the grape-growers themselves in conjunction with the County Horticultural Commission of San Joaquin County.

Another project being conducted by the Citrus Experiment Station is a study of the natural control of certain small moths, the larvae of which attack the skin of citrus fruits and cause them to drop. These are *Tortrix citrana*, *Platynota tinctana* and *Holcocera iceryella*. This work is supported by the University and certain orange growers' associations. It will probably be reported on in full during the coming year.

In addition to the introduction work outlined above which is directly related to the solution of economic problems, an effort is being made to work out the biology of the natural enemies of the black, red, and purple scales, as well as those of certain other important pests. The work on parasites of the black scale is practically completed and will be submitted for publication in the near future.

CHAIRMAN GEORGE A. DEAN: The next person on the program has had not only an opportunity of making a thorough study of the alfalfa weevil parasites in the infested areas of the Northwest, but also an opportunity of spending two years in Southern Europe where he made a thorough study of the alfalfa weevil parasites in that district. Mr. T. R. Chamberlin will present his paper on "The Introduction and Establishment of the Alfalfa Weevil Parasite." (Applause)

THE INTRODUCTION AND ESTABLISHMENT OF THE ALFALFA WEEVIL PARASITE, *BATHYPLECTES CURCULIONIS* (THOMS.), IN THE UNITED STATES

By T. R. CHAMBERLIN, *Bureau of Entomology, U. S. Department of Agriculture.*

ABSTRACT

The following article relates briefly certain features connected with the shipment to Salt Lake City, Utah, of *Bathyplectes curculionis* (Thoms.), an internal parasite of the larva of the alfalfa weevil, *Phytonomus posticus* (Gyll.). It describes the release of

the parasite in Utah, its rapid diffusion, and the various methods used since its colonization there to determine the extent of parasitism attained by it. Its previous history and its geographical distribution are considered.

The campoplegine *Bathyplectes curculionis* (Thoms.) is an internal parasite of the larva of the alfalfa weevil, *Phytonomus posticus* (Gyll.). Adult *Bathyplectes* issues in the spring from overwintering cocoons, and oviposits in early larvae of the alfalfa weevil. The development from egg to full grown larva requires about two weeks. The full grown larva issues from the prepupal larva of the weevil after the cocoon of the latter has been spun and spins its own cocoon within that of the weevil. In most of the regions studied the adults issue from these cocoons in about two weeks and oviposit in weevil larvae of the next generation. This occurs at about the period of the greatest abundance of the weevil larvae. These larvae also are destroyed and cocoons of *Bathyplectes* spun in weevil cocoons as in the earlier generation. The cocoons of the second generation are usually darker in color than those of the first generation and of heavier construction. All are from medium brown to chocolate brown in color, with a distinct white band around the middle. Most of the *Bathyplectes* of the second generation remain in the cocoons as prepupal larvae until the next spring, when they pupate and issue soon afterwards. Some heavy dark brown parasite cocoons have been obtained from weevil larvae collected so early in the spring that it is probable that they do not represent second-generation parasites but overwintering cocoons, which, for some unknown reason, have been made by first-generation larvae.

Previous History and Distribution

The species was first described by Thomson in 1887 (*9, p. 1113*) and assigned to the genus *Canidia* which had been erected by Holmgren in 1858 (*6, p. 103*). Holmgren had confused the species with *Campoplex subcinctus* Grav. Because of the pre-occupation of *Canidia*, Ashmead (*1*), in 1900, changed the name of the genus to *Canidiella*. Schmiedeknecht (*8, p. 1673*) in 1909 could find no good reason for this change of name and returned the species to the genus *Canidia*. In 1914 Viereck (*10, pp. 20 and 28*) found the genus *Canidia* isogenotypic with *Bathyplectes* Förster (Szplegeti) (*4, p. 176*) and gave the latter name preference.

Following a report of E. G. Titus in 1910, on the occurrence of *Phytonomus murinus* (Fab.) in Utah, in which parasites were not mentioned, Martelli (*7, p. 229*) called attention to the larval parasite *Canidia curculionis* (Thoms.). He described the form of the cocoon and the apparent appearance of two generations at Acireale, Sicily. He also

gave the length of the period from egg to adult in the first generation as from 27 to 31 days.

From the foregoing it will be seen that the economic work on this parasite previous to that begun by the Bureau of Entomology was not extensive.

In 1911 W. F. Fiske, working on parasites of the gipsy moth in Italy for the Bureau of Entomology, made dissections of 13 lots of weevil larvae, some of which were those of the clover leaf weevil (*Hypera punctata* Fab.). The parasitism of these lots varied from none to 43 per cent, and averaged 6.2 per cent. The material was collected at Portici and vicinity.

In 1912 W. R. Thompson reared in the laboratory at Portici many lots of larvae from various parts of Europe. From 5,737 larvae, 878 *Bathyplectes* cocoons, most of which were of the species *curculionis*, were obtained, indicating a parasitism of 12.5 per cent. For reasons which will be given later, it will be seen that the indicated parasitism here must have been low.

N. A. Grossheim (*5, p. 23*) in 1913 mentioned a 3.16 per cent parasitism by what he called *Canidiella curculionis*, in the province of Kuban, Russia, but he called attention to the jumping habit of the cocoon, which indicates that he was dealing with the species *Bathyplectes corvina* (Thoms.) and that either the species *curculionis* was not present or its cocoons were not distinguished from those of *corvina*. It is interesting to note in this case that Grossheim worked on other species of parasites and stated that together they destroyed 71 per cent of the weevils (*5, p. 24*).

The foregoing citations indicate that the insect has a wide range. Schmiedeknecht, in his Opuscula Ichneumonologica, states that the species is widely scattered and one of the most common of the genus. Dr. W. R. Thompson has reared it from many parts of Germany, Switzerland, and Italy, and the writer has reared it from many parts of France, Italy, and Sicily (*2, p. 627*). Dr. Thompson also, on two occasions, secured what he called a male *Canidia* in Tunisia, by sweeping.

Importation

Shipments of the parasite to the United States were made by W. F. Fiske in 1911, by H. S. Smith in 1912, and by W. R. Thompson in 1912 and 1913. In the early shipments the parasites usually came in cocoons spun up inside weevil cocoons, or the cocoons were separated out from weevil cocoons. Thompson's shipments of 1913 consisted in part of

cocoon material and in part of larvae of the alfalfa weevil which contained some parasites. Most of these larvae were collected in Switzerland. The weevil cocoons were usually placed in fine-mesh screen cans, which were enclosed, three together, in 3-inch by 5-inch by 8-inch boxes of soft absorbent wood. The boxes were wrapped in bundles with Indian head and burlap and shipped in cold storage to Salt Lake City. The larvae were shipped in similar boxes inside of cloth bags with alfalfa as food. These boxes were wrapped in bundles and shipped in cold storage as in the case of the cocoons. On arrival in Salt Lake City many larvae had died from causes other than insect parasitism, the number varying from a small proportion to over half of the total. Some of these larvae were killed by disease, others by unknown agencies. Undoubtedly the death rate was increased by forcing into the bags more alfalfa than was required as food.

Liberation

In 1911, 100 adult parasites, recorded in the notes as *Canidia* sp., issued from imported material. Forty of these were liberated into field cages near Sandy, Utah, by T. H. Parks, and later these cages were opened to the field. Parks also conducted some reproduction experiments in the laboratory which showed that the parasites oviposited in larvae of practically all sizes. The time for development from egg to full grown larva was about 14 days. The full grown larvae from this material remained inside their cocoons over winter.

In 1912 G. I. Reeves released 48 male and 121 female parasites directly into the field.

In 1913 and 1914 P. H. Timberlake and his assistant, L. P. Rockwood, liberated 1,335 parasites in fields at Ogden, Kaysville, and Salt Lake City. All those released in the two years came from the shipments of 1913. Most of those issuing from *Bathyplectes* cocoons shipped as such were of the first generation and emerged in 1913. The *Bathyplectes* cocoons obtained from weevil larvae were largely of the second generation and there were few issuances from them until 1914. The total issuance from *Bathyplectes* cocoons secured from larvae was low, rarely exceeding 50 per cent, and the secondary parasite, *Mesochorus nigripes* Ratz., formed from 24 to 65 per cent of this issuance. The issuance from *Bathyplectes* cocoons shipped as such varied from 35 to 73 per cent, and in most cases *Mesochorus nigripes* formed the greater part of this issuance. *Gelis*, mostly of the species *stevenii* Grav. issued from this material also, and in one case made up 24 per cent of the total issuance.

From this brief account it can be seen that the liberations of *Bathyplectes curculionis* were not extensive. The recorded total was 1,544. This fact makes the rapid spread of the insect, which is to be described later, truly remarkable.

Establishment and Diffusion of Bathyplectes Curculionis

In the summer of 1914 *Bathyplectes* was scarce except at Murray and at Salt Lake City in the fields in which parasites had been released, but by 1916 it had spread to fields along the bench lands along the east edge of the Salt Lake Valley, to a distance of 8 or more miles from these fields. A parasitism of 22.5 per cent was found in over 3,000 cocoons of the weevil collected during the summer in this locality. The same year the parasite was found in the Weber Valley east of Salt Lake City, at a maximum distance of about 30 miles, and the parasitism there ranged from 2 to 30 per cent. The parasite was also found at Ogden and Kaysville. In 1917 it was found at Provo, Utah, about 35 miles from Salt Lake City. In 1918 it was abundant all over the Provo Bench and rather scarce at Brigham City, about 50 miles north of Salt Lake City. In 1919 the parasite was found as far south as Salina, Utah, 120 miles south of Salt Lake City, and it was abundant at Paris, Idaho, 95 miles north. In 1920 it was found at a maximum distance of about 230 miles from Salt Lake City, the points being Ashton, Idaho; Granger, Wyoming; Geneva, Idaho; Duchesne in eastern Utah; Skull Valley in western Utah; and Elsinore in southern Utah. At Geneva and Ashton, Idaho, the writer was unable to find the host insect, although it was known to be near these places. The parasite was not found in the isolated weevil colonies at Payette, Idaho, Reno, Nevada, and Paonia, Colorado, until after introductions were made. At the present time it seems to be accompanying the weevil as it spreads to new territory. Larvae of the weevil collected last summer near Casper, Wyoming, a newly discovered and isolated district, contained larvae of *Bathyplectes*.

This case of diffusion indicates a spread of at least 196 miles in six years; that is, from Ogden, Utah, in 1914 to Ashton, Idaho, in 1920. Such spread suggests remarkable powers of flight as well as a high rate of reproduction on the part of the parasite.

Extent of Parasitism

Ever since the parasite has become colonized in Utah, various efforts have been made to determine the extent of parasitism, but these efforts have not been continuous nor have the results obtained by the various methods used been strictly comparable. It is a fairly simple operation

to determine parasitism in a given lot of weevil larvae, but these results do not reveal what the true condition would have been if the same larvae had been allowed to remain in the field until they were spun up. Furthermore, to get a true measure of the activity of the parasite, a complete history of the extent of parasitism throughout the whole portion of the year when weevil larvae are in the field should be obtained. As this work is carried on some attempt also should be made to determine the larval population of the weevil throughout the same period, for parasitism may be high at a certain time but rendered insignificant because few weevil larvae are present. Thus far the Salt Lake Station has been unable, for various reasons, to obtain such complete records as are desirable, but those in hand are not without value.

In 1916 and 1917, and at times since, cocoons of the weevil were collected from alfalfa stubble after the cutting of the first crop, and the parasitism estimated by comparing the number of *Bathyplectes* cocoons obtained with the total number of weevil cocoons represented. If these examinations are made soon after the weevil larvae have spun, if there are no indications of depredations by birds, and if the cocoons have not been broken up by various control methods such as brush dragging, the results obtained may be fairly reliable; what they actually represent at various times, however, is largely problematical.

Estimates may also be made by rearing a definite number of weevil larvae in the laboratory, and comparing the number of *Bathyplectes* cocoons obtained with the total number of larvae in the collection. This gives a low figure since, as a rule, many larvae die before spinning, and not all the *Bathyplectes* present spin. If we do not wish to get percentages we can compare the number of *Bathyplectes* cocoons obtained with the number of adult weevils issuing; and such a result may, as a matter of fact, represent more closely than any other the true course of events in the field.

Dissections of larvae as collected from the field are dependable as regards the actual parasitism in the lot, but if we dissect all stages of larvae we include a number which have not been allowed the fullest opportunity of becoming parasitized. Dissections of larvae collected just before spinning would practically eliminate this objection, but it is impossible to select larvae in just this condition, and we must be content with dissections of large larvae, some of which might actually live several days in the field before spinning.

To illustrate the variation in results obtained by different methods, a lot of 821 larvae collected in Salt Lake County on June 6,1924, may be

cited. Sixty-two larvae of all sizes dissected showed 79 per cent parasitism. From the remaining 759 larvae, which were placed in a can and fed once, 304 *Bathyplectes* cocoons were obtained, indicating 40 per cent parasitism. From the whole lot of larvae, however, only 15 adult weevils were obtained. Thus in the lot, reproduction of *Bathyplectes* compared with reproduction of the weevil was about 20 to 1.

The studies of parasitism in 1916 and 1917 were made largely after the season's spraying work had been completed, by collecting cocoons. The results of the work of 1916 showed, as previously stated, a parasitism of 22.5 per cent. In 1919 and 1920 many larvae were opened in the field in the districts where *Bathyplectes* had been longest established and parasitism often exceeded 90 per cent, at times adult parasites swarming from the fields in such numbers that it seemed impossible for any of the larvae present to escape them.

With the lessening of weevil injury during the next few years, *Bathyplectes* to all appearances decreased also, and in the writer's opinion it has not, in the sections studied, returned to its earlier abundance, although the last two have been good weevil years.

In the last two years other observations upon the extent of parasitism have been made, some during the height of the weevil season and others later. In 1924, in a rapid survey between Gunnison, Utah, and Ashton, Idaho, about 400 miles in a north and south line, dissections of the catch, most of which consisted of large larvae, showed parasitism to vary from 29.9 to 84.5 per cent in fair-size lots and from none to 100 per cent in small lots. In many places where weevil larvae were so scarce that good sized collections could not be made, parasitism remained high.[1]

In 1925 dissection of large larvae showed parasitism in fair sized lots to vary from 8 per cent at Delta to 65 and 97.3 per cent at Heber and to 85 per cent at Salt Lake City.

Many observations during the last two seasons were made after the height of the weevil attack was over. This was done for two reasons: First, because early in the season the laboratory force had been engaged in releasing other species of parasites brought in from Europe and could not make the necessary studies on the parasite already colonized; and, second, because it has been felt that the study of parasitism in late larvae is the more important. The parasitism at the height of the

[1]For example, at Pocatello, Idaho, on June 17, 20 out of 23 large larvae, 4 out of 5 medium sized larvae, and 2 out of 2 small larvae were parasitized. At Sugar City, Idaho, 15 out of 15 larvae and 20 out of 25 medium sized larvae contained parasites.

season is as high, it is believed, as we may reasonably expect from any single species; and it is desirable to learn, if possible, where, in the whole larval period, the parasite fails, if at all, so that the destruction may be increased by auxiliary parasites.

Observations, especially those of the last two seasons, show considerable variation in the extent of parasitism at different times in the same field. Low parasitism is sometimes found temporarily where weevils and parasites are known to be abundant. These occasions may represent periods between the broods of parasites or some time after the bulk of the final brood has spun up. What these temporary slumps amount to is problematical, but it seems likely that straggling larvae following the second brood of *Bathyplectes* may become an important source of weevil increase, especially in those fields where, for reasons not thoroughly understood, straggling larvae seem to persist in considerable numbers. There is some indication of increase in parasitism toward fall. If this should prove to be the case, it may be caused by straggling second-generation *Bathyplectes*, but more likely by *Bathyplectes* issuing prematurely from overwintering cocoons. There has been evidence of a slight issuance from typical overwintering cocoons in the laboratory, and such an issuance occurring in the field, in view of the great number of *Bathyplectes* cocoons and the relatively small number of larvae present, would probably effect a noticeable increase in parasitism.

All of the observations recorded show that the making of consistent observations upon parasitism over the whole period in which larvae appear in the field is most desirable, and suggest that the figures obtained in the past may represent passing conditions and may not be an indication of the whole effect of the parasite upon the weevil.

The results of the work on this parasite are admittedly but a beginning and suggest that if *Bathyplectes* may in any way be considered defective as a controlling agent, it is because its generations are too clean cut and because it does not continue consistently effective throughout the whole period when larvae are present.

Summary and Conclusions

During the years of 1912, 1913, and 1914, numbers of the larval parasite, *Bathyplectes curculionis*, were released in the fields of Utah. Colonization seems to have been easily effected, but diffusion during the first few years was slow. Later, the spread was very rapid, so that after about eight years the species was found 230 miles from Salt Lake City, and was practically covering the weevil territory. The extent of para-

sitism has always been reasonably high, and at times very high. *Bathyplectes* does not appear present in the fields to parasitize the larvae heavily at all periods of the year, a fact which leads one to suppose that its work might well be supplemented by a many-brooded larval parasite, which would work late into the season. It is probable that the species *Tetrastichus incertus* Ratz. (*3*) would be suited to this purpose.[2]

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[2]For experiences with a related species, *Tetrastichus giffardianus* Silvestri, parasitic upon the Mediterranean Fruit Fly, see the following:

Pemberton, C. E., and Willard, H. F. Interrelations of the Fruit Fly Parasites in Hawaii. Jour. Agr. Research, Vol. 12, No. 5. pp. 285–296, Illus. 1918.

Willard, H. F. Work and Parasitism of the Mediterranean Fruit Fly in Hawaii during 1919 and 1920. Jour. Agr. Research, Vol. 25, No. 1, pp. 1–7, 1923.

CHAIRMAN GEORGE A. DEAN: Those who had an opportunity of visiting the European Corn Borer Laboratory at Arlington, Massachusetts, regret that Mr. Jones is not here to present his paper. For many years Mr. Jones was with Mr. Burgess on the parasite work of the gipsy and brown-tail moths, but he was transferred to take charge of the European Corn Borer parasite work, which he has developed to a high stage of efficiency. His paper will be read by Dr. Huber of the Ohio Experiment Station, who is cooperating very closely with the Bureau of Entomology in the introduction of parasites in Ohio. (Applause)

SOME NOTES ON THE TECHNIC OF HANDLING PARASITES

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ABSTRACT

Parasites are so specialized that no two species may be handled in the same way. Knowledge of the reactions, habits, and general life history of a species must be enlarged and added to step by step. The solution of the problem of handling parasites successfully is obtained only by making use of such favorable points as present themselves and modifying methods in such a way as to take advantage of any new information that study and observation may yield. Proper coordination between various steps is necessary. The handling of two breeding problems is explained to show why and how certain technic was developed.

The technic of handling parasites is a very broad subject. Parasites are so specialized that almost every species differs in habit and reaction from other species. Even those of the same genus which attack the same kind of host may differ widely. An actual case exists where one such species was logically and perfectly handled with splendid results, while another species of the same genus offered an almost impossible problem. Under such conditions general rules for procedure cannot be laid down.

Although little may be known concerning the life history of a parasite, some stage can usually be found in which it is possible to collect and transport it. In transportation one or all of the fundamental requirements of light, temperature, and moisture may have to be considered, together with ventilation, type, size, weight, and material of shipping containers to supply satisfactory conditions for the journey. The "trial and error" method usually is employed to insure the arrival of at least some parasites in good condition. Failures offer as valuable lessons as successes if the cause of failure can be determined.

In the laboratory one adds step by step to the knowledge of the reactions, habits, and general life history of the parasites. The "trial

and error" method must be used frequently, and extremely careful observations made. One increases one's ability to analyze results, to take advantage of favorable points and possibly to develop some entirely new method of attack so that a factor works for, instead of against, a successful solution of the problem. A thousand and one separate problems must be solved and the proper coordination developed as one proceeds. How this is accomplished is best shown by a simple example.

Our problem was to breed *Habrobracon brevicornis* Wesm. in large numbers for liberation. This species is a braconid parasite of the corn borer received from the parasite laboratory at Hyères, France.

Mating was the critical point. Unmated females deposited eggs, but the resulting offspring were always males. Seven types of cages were tried under identical conditions. Progeny from the best three types averaged about 2% female in a 21 by 17 by 5 inch cage, 7% in 4 by 1 inch glass vials, and 13% in smaller "homeopathic" vials. The experiment with the homeopathic vials was continued, and it was found that by apportioning 5 females and 10 males to each vial, the percentage of female progeny was raised to 17. Temperature change alone raised the rate from 17% to about 40% at 85°F. Keeping the sexes separate for twenty-four hours before mating gave a still higher percentage of female offspring.

While the mating problem was being studied many reactions, habits, and peculiarities of the parasite under different conditions were noted. Adult females stung host larvae until the latter became motionless, when the adults fed repeatedly at the puncture holes. Artificial food prolonged life somewhat, but when a frequent, regular supply of host larvae was furnished, the blood of these alone was sufficient for the females. Artificial food was necessary to prolong the life of the males for more than four or five days, but suitable mating methods secured results before the expiration of this time, so that finally no artificial food had to be given to either sex.

Homeopathic vials proved hard to keep clean, and parasites were often injured manipulating the cotton plugs. Too much silk was spun by the host larvae near the plug, and several other disadvantages existed. Other small containers were experimented with. Glass-topped stender dishes were found ideal in every way and were handled more than four times as quickly as the homeopathic vials. The vials are still used to secure mating, but stender dishes have supplanted them for actual oviposition.

Experiments were conducted to determine the proper number of para-

sites and host larvae for each stender dish and the time necessary for a suitable average egg deposition. Forty eggs or more per host produced nothing, or at best but undernourished progeny. On the other hand, an insufficient number of eggs used up the host larvae too fast. An average of twenty eggs per host produced good results, and three *Habrobracon* and two corn borers per stender dish gave a suitable average over twenty-four hour periods.

Host larvae on which eggs have been deposited, never move again. We took advantage of this fact to remove them to a glass plate or cardboard, and no detriment to the parasite larvae resulted. We could, therefore, leave the females constantly in the stender dish and add two live borers each morning when the parasitized individuals had been removed. A fairly moist, warm atmosphere during the larval period gave the best results. As soon as the short feeding period was finished the parasite larvae attached their cocoons firmly to the glass or cardboard. When the larvae had thus packed themselves in their silken cocoons attached to the cardboard, the whole strip was immediately shipped. Upon arrival at their destination they were usually still in the cocoons and in good condition, but ready to emerge for mating and liberation. The sexes are easily separated for mating by using a narrow open cage with a glass background facing the light. The light attraction holds the adults in the cage, and the light background enables one to distinguish the ovipositor of the female and to note differences in the antennae of the sexes. When touched with a camel's hair brush the adults drop or fly downward and are caught in homeopathic vials for mating as previously explained.

The methods used in the example given above may be summarized as follows: Separate the sexes for twenty-four hours without food, then place them together for three days at a temperature of 85°F. with one corn borer each day to furnish food; change to stender dishes with three females and two corn borers per dish, remove the parasitized borers each morning to a piece of cardboard, and add two fresh borers.

Another example may be given in less detail which shows different factors involved, but has the same ultimate end, namely, to breed large numbers of parasites in good condition for liberation. This example is *Exeristes roborator* Fab., an ichneumonid parasite of the old Pimpla group. Dr. W. R. Thompson, in charge of the parasite Laboratory at Hyères, France, had solved certain fundamental problems in breeding this species. We modified and improved his technic to get better coordination. Where he had used lantern-globe cages we

gradually developed a compartment cage which gave efficiency and speed in handling the work, and at the same time provided better living conditions for the parasites. Mating was very satisfactorily secured with this species. In fact, we remove the males after several days as superfluous. By placing host larvae and sugar water in the only light part of the cage, the light attraction was capitalized and a place to oviposit and feed was constantly at hand. The back of the cage was made of removable strips which gave an opportunity for cleaning and handling material in three compartments at the same time while heliotropism held the adults in the front of the compartments. Each section had two pieces of cotton wet with sugar water and a supplementary food supply of freshly killed borers pinned to a piece of corn pith. *E. roborator* pierces the plant with her ovipositor, locates the borer, stings it to death, and lays her eggs on it. Following Dr. Thompson's method, we take sections of corn pith, make an artificial tunnel and fill this with corn borers. First we crush their heads so they cannot destroy the pith of the cornstalk by boring before they are killed by the parasites. This tunnel is closed by means of a wheat-straw paper strip held in place with small elastic bands. When "loaded" this section of pith is placed in the lightest part of the cage. The next day it is removed and a fresh one added.

The young of *Exeristes roborator* are cannibalistic and only one parasite completes development on a single host. We therefore open the piths, remove all the eggs, using a camel's hair brush, and place them on a glass plate temporarily. We then kill by means of hot water as many corn-borer larvae as we have eggs. Countless experiments were conducted to show that the hot water method is preferable to other methods. Subsequent experiments determined the exact temperature and time of immersion required to obtain the best results. This is a delicate and critical operation, and slight variations are disastrous. The killing point must barely be passed since further time coagulates the body contents. The corn borers are then isolated in small glass shell vials and one parasite egg is placed on each borer.

Racks have been developed for holding these vials at an angle of forty-five degrees. These are put in trays with the vial openings facing each other and cotton strips placed between. The weight of the next tray above forces the cotton tightly against the vial openings, thus doing away with the use of individual cotton plugs. The parasite egg hatches in about twenty-four hours and the resulting larva feeds on the dead borer. A moist warm atmosphere is best for its development.

A second borer sometimes must be furnished, but usually this is not necessary if temperature and time of immersion have been accurately gauged. When it has finished feeding, the young parasite spins a rough cocoon attached to the glass vial and we then set it aside for hibernation, future breeding, or liberation. For this rest period the vials are packed in small cardboard boxes. For liberation these boxes are placed in an emergence cage darkened except for one section. The adults emerge, come to the light, and find themselves in a large, ventilated cage where they move freely and mate. We have two of these cages and each day take one away and put the empty one in its place. If properly placed the light attraction holds the parasites in their cage until a cover is put in place. A further opportunity to mate is given and the whole cage is taken to the field, where the adults are allowed to escape. We merely make a careful estimate of the number of adults liberated each day. An accurate emergence count is possible by this method only at the end of the emergence period by examination of the total vials used in the cage. This accurate total figure when checked against our daily estimates and pro-rated gives approximately the number for each liberation point. Slight inaccuracies exist, but these are preferable to the risk of having the adults injured or improperly mated for the sake of the more accurate counts possible by other emergence methods.

The matter of washing shell vials was a problem in itself. The method finally adopted was to pack them in wire racks, boil them in a solution of lye, rinse with a hose, boil again in the best laundry soap solution, and rinse thoroughly in hot clean water.

Both species of parasites mentioned in this paper parasitized full-fed host larvae. Fortunately we could collect these at a period when they no longer required food and could work out methods for building up a reserve supply. They are placed in wire screen cages between folds of newspaper and stored in a moist cold atmosphere.

It has not been possible to go into the countless "trial and error" experiments which the effort to develop a satisfactory method of handling parasites entailed. Every step had to be studied and analyzed, and when a device proved successful, more experiments were conducted to find out how it might be made more so. The simplest equipment was used where this was possible.

In handling parasites a printed paper, a slight hint, a random thought, or even an accident sometimes gives one the germ of an idea which later solves a most difficult problem. In a similar manner the most perfect technic may be made more effective and less expensive by

a simple improvement. The technic of handling parasites in general is so little understood and varies so greatly in every case that the slightest contribution to the subject may be of value.

CHAIRMAN GEORGE A. DEAN: The next and last paper on the program will be given by one who has made for himself a world reputation in animal parasitism. Professor W. B. Herms, head of the Department of Entomology, University of California, will give a paper on "The Effects of Parasitism on the Host and on the Parasite." (Applause).

THE EFFECTS OF PARASITISM ON THE HOST AND ON THE PARASITE

By W. B. HERMS, *Professor of Parasitology, University of California*

ABSTRACT

The life of a parasite, contrary to general opinion, is not an easy one, it is full of dangers and the parasite is rigorously circumscribed. Parasitism is an achievement and the term degenerate is not aptly applied to this mode of living. Parasites are adapted to this mode of life in two general respects, namely (1) *physiologically* and (2) *morphologically*, and these adaptations become the more intense and exclusive as this mode of life progresses.

A true parasite should not destroy its host,—the life of the host and that of the parasite have become closely tuned to each other and the slightest change in the mode of life of either may result in serious disturbances in the life of the other.

It appears that many of the more dangerous blood sucking species of insects have a rather benign "bite," note the difference in the bite of *Anopheles maculipennis*, an important malaria vector, and *Aedes dorsalis*, a salt marsh species. A blood sucking insect that is to become a successful carrier of human disease will probably have to make its blood-lust less offensive to its host.

The laws governing the development of a successful parasite are operative in the development of all successful living beings, it is therefore necessary to study the effects of parasitism on the host and on the parasite from a more comprehensive biological point of view.

In spite of the fact that the life of a parasite is commonly regarded as an easy one, it is full of dangers, rigorously circumscribed and leads eventually only to extinction. The study of parasitism is fascinating, its interpretations are dangerously full of pitfalls and its definition is often embarrassingly comprehensive, for example living at the expense of another, or it may be profoundly technical. The origin of the parasitic habit is not a matter for us to discuss at this time, whether it be the result of necessity or the result of following up an advantage, but we are interested in the effects of such laws as operate to produce adap-

tive responses in the realms of parasitism. Since the object of this form of life is the getting of food, a matter common to all living things, it is after all only a specialized mode of living. If parasitism has been accomplished by following up an advantage, then in many respects it is an achievement and if it is a result of necessity it is no less so. The louse, the flea and the tapeworm represent a sort of achievement.

The term "degenerate" as applied to the parasitic mode of living is hardly appropriate unless the term may be applied to the reduction of certain organs which become more or less useless to the organism, such as certain sense organs and organs of locomotion. Such reductions also occur in many non-parasitic forms living under highly specialized conditions, e.g., loss of eyes in certain cave-inhabiting insects. This form of degeneracy so far as the parasites at least are concerned, might better be designated as a form of "hopeless specialization," according to Wheeler (Social Life among the Insects) since, as he puts it, it leads eventually to extinction. It is barely conceivable that stress of circumstances might be avoided by gradually working back from this mode of living to that of freedom. Wheeler remarks that "the individual parasite buys its rare successes very dearly, for it must often run the gauntlet of great resistance and animosity on the part of a too healthy host, and must at the same time carefully avoid seriously injuring that host and thus bringing about its own destruction. . . . Parasitism so far as the race is concerned, is anything but a promising or profitable business." But there we are reminded that parasites form but a small part of the species of animals and plants which as Root[1] has put it, "have perished from the earth without leaving descendants because their specialization for particular environmental conditions was so beautifully exact that it left them helpless, with no choice but extinction, when those environmental conditions were replaced by others."

Most insects employed in biological control are "refined predators (Wheeler) which usually on growing to their full stature, kill the hosts they have been carefully sparing. . . . Since this is not exactly the form of parasitism exhibited by other organisms such as the tapeworms,certain barnacles and bacteria, I prefer to call it 'Parasitoidism.'" This form of parasitism would seem to be about as dangerous to the parasite as it is to the host, but lends itself well to insect control. When true parasitism has been achieved and a balance has been established, it would

[1]Root, F. M. 1924. Parasitism among the insects. The Scientific Monthly, vol. IX, pp. 479–495 (November, 1924).

appear that its economic function, at least in biological control, has been accomplished.

Parasites are adapted to their mode of life in two general respects, *physiological* in that they require a certain species or group of species as food reacting accordingly, and *morphological* in that their structure is modified to this end. These adaptations become the more intense and exclusive as this mode of life progresses, i.e., the further back one goes in the history of a parasitic species, the more nearly like its free living relations it becomes (Ludwig von Graff in "Das Schmarotzertum in Tierreich"). This accommodation is obvious in those species in which the young are free living and resemble the young of wholly free living species. von Graff cites the extreme case of the decapod louse *Sacculina carcini* as illustrative of this recapitulation. The parasitic cirripedes (fish lice and decapod lice) show striking structural adaptations to a parasitic mode of living, thus the first pair of antennae may become well formed hooks for holding fast and the first pair of maxillipedes become suckers, the mandibles are transformed into piercing organs and the mouth becomes a sucking tube.

With the introduction of easily assimilable substances into the digestive tract of the parasite, the digestive organs gradually become modified and with the entire body in direct contact with "predigested food" as is the case with tapeworms and other intestinal parasites, also to a large extent with flesh fly larvae, the outer covering of the parasite becomes modified to allow direct absorption with the result that the digestive tract becomes wholly unnecessary and may be entirely lost. Modification of the digestive tract is not restricted to parasites by any means.

The modification or loss of wings in wholly parasitic insects such as the Mallophaga, Anoplura and certain Hippoboscidae is commonly said to be the result of the parasitic mode of life,—however, this phenomenon is not a characteristic of parasitic forms alone as all will readily concede. There are numerous examples of wing reduction and extreme modification of appendages in non-parasitic forms.

Although plasticity in parasites both as to morphology and biology is largely lost there is here nevertheless still a field for experimentation. A notable example is to be found in *Pediculus humanus* which occurs in two extreme forms, *Pediculus h. capitis* and *Pediculus h. corporis*. Keilin and Nuttall[2] have given conclusive evidence that while these strains

[2]Keilin, D. and Nuttall, G. H. F. 1919. Hermaphorditism and other abnormalities in *Pediculus humanus*. Parasitology, vol. XI, nos. 3 and 4, pp. 279–328, pls. xii–xvii.

may be distinguished on morphological grounds, they can be changed one to the other by changing the environment, i.e., "typical *capitis* lose all their distinctive morphological characters when raised experimentally on man under conditions which are favourable for the propagation of *corporis*, and they acquire all the morphological characters of *corporis* after four or more generations." (Nuttall[3]) Adaptations of each of these races to the host are apparently quickly acquired. Typical *capitis* is more active at a lower temperature than is *corporis* due, no doubt, to the usual environment on the host, the former living a more or less exposed life and the latter protected in a warmer situation. *Capitis* is smaller in size and has stouter legs, hence can climb hairs more rapidly than can *corporis*. Under normal environment *corporis* imbibes larger meals at longer intervals in conformance with the resting habits of the host, while *capitis* with continuous opportunity for feeding takes a small amount of food at short intervals. Furthermore, Nuttall (loc. cit.) remarks that, "The effect of darkness no doubt is responsible for *corporis* possessing longer and slimmer antennae and legs than *capitis*. The latter is more exposed to light upon the head than is *corporis* beneath the clothing in most instances. It is, of course, well known that arthropods inhabiting dark places have longer antennae and legs than those living exposed to light." Adaptation to the skin color of the host appears to be obvious. Lice collected from the heads of the brown skinned Gilbertese during my investigations among these people on Fanning Island[4] were strikingly sooty in color. Rearing lice in pill boxes of different colors inside as carried on by Nuttall[5] shows that change of color is rather easily accomplished.

Nuttall's conclusions based on the observations cited above are very interesting, namely, "There is little doubt in my mind that *capitis* is being converted into *corporis* today in nature, and that the latter, when man has become hairless, will constitute a species whose birth we are witnessing."

The wider adaptability of parasites, i.e., adaptation to different host species as compared to different parts of the body of the same host as

[3]Nuttall, G. H. F. 1919. The systematic position, synonymy and iconography of *Pediculus humanus* and *Phthirus pubis*. Parasitology, vol. XI, nos. 3 and 4, pp. 329–346.

[4]Herms, W. B. 1925. Entomological observations on Fanning and Washington Islands, together with general biological notes. Pan-Pacific Entomologist, vol. 2, no. 2, pp. 49–54.

[5]Nuttall, G. H. F. 1919. The biology of *Pediculus humanus*. Parasitology, vol. XI, no. 2, pp. 201–220, pl. x.

in *Pediculus humanus* is shown in the different races of *Sarcoptes scabiei*, the itch or mange mite of humans, swine, horses and other animals. While there appear to be specific differences in pigmentation, cuticular markings and chaetotaxy, these are not constant though many insist on the validity of these characters. Transfer from host to host of different species can be more or less readily accomplished. Other examples could be cited to illustrate this adaptability such as certain polymorphic mamallian trypanosomes (*T. brucei*, *T. gambiense* and *T. rhodesiensi*) as cited by Duke[6] who refers to these as physiological variants of a single species.

That the termite genus *Gnathotermes* with its two species *Gn. aurivillii* Holmq. and *Gn. havilandi* Holmq. may find its origin in a capitular deformity produced by a parasite is pointed out by Kemner[7] who found a fly larva which he designates as *Larva termitovorax* occupying the very large head capsule of the termite. Kemner points out that the specimens of soldiers on which the genus is based resembled closely the genus *Termes* and specifically *Termes malaccensis* Hav., and that the head appeared to be inflated. The genus appears to be established on only three specimens of soldiers, two for the first named species and one for the second. The question is raised, What would the genus *Gnathotermes* be without this deforming parasite? Furthermore, in order that this might be a true deformation of the head of the imago, it must have become parasitized while yet immature. Other cases of parasites occurring in the head of an insect host are to be found in ants, particularly *Camponotus pennsylvanicus*.[8] The parasite is a Phorid, while the parasite reported by Kemner is not identified other than that it is said to be probably a Muscid. In this connection we will, of course, recall that several species of Diptera, e.g., *Cephalomyia ovis*, pass their larval period in the head (nasal sinuses) of certain vertebrates. The Oestridae are mostly quite large while the Phoridae are minute.

If the head deformity of the termites above mentioned is the immediate result of parasitism then it would appear to be possible to

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[6]Duke, H. L. 1923. Further inquiries into the zoological status of the polymorphic mammalian trypanosomes of Africa. Parasitology, vol. XV, pp. 358–395.

[7]Kemner, N. A. 1925. Larva termitovorax eine merkwürdige parasitische Fliegenlarva, die im Kopfe von Termitensoldaten lebt, und durch die Verunstaltung desselben Veranlassung zur Aufstellung eines besonderen Termitengenus mit zwei Arten gegeben hat. Archiv für Zoologi Utgivet av K. Svenska Vetenskapsakademien Band 17, A. No. 29, 15 pp. Taf. 1.

[8]Pergande, Theodore, 1900. The ant-decapitating fly. Proc. Ent. Soc. of Wash., vol. 4, pp. 497–502 (Dec. 1900).

determine this experimentally, i.e., larvae reared in the absence of the parasite should have normal heads although it must be borne in mind that soldier termites as a rule have large heads, necessary to support their massive jaws. To be a true generic character traceable to parasitism historically it should be transmissible to the offspring even in the absence of the parasite, otherwise it is merely a pathological result like unto an insect gall. Grassi and Wheeler long ago called attention to the production of caste in termites due to parasitism, but there is some difference at least between caste and genus.

Kemner's observation leads me again to refer to the Dipterous family Phoridae[9] in which we find a wide range of food habits from scavenger to commensalist and parasite, together with a wide range in form, from a rather typical winged Dipteron to a wingless flea-like creature almost totally unlike all others of the same family. It is interesting to note that the adult of *Apocephalus pergandei* Coq. which, as already stated, lives as a larva parasitically in the head of the carpenter ant, *Camponotus pennsylvanicus*, holds strongly to the generalized family characteristics while females of *Puliciphora*, for example, are widely divergent from the family characters, being apterous or semi-apterous resembling the Pulicidae more than the Phoridae (Malloch), and the very little known larvae are apparently non-parasitic. This may need modification on further study. After all, however, we are brought back to the fact that the ant decapitating species as an adult has much need of functional wings and aggressive habits to enable it to parasitize its host. It does not always follow that a generalized feeder is also generalized structurally,—other factors in the history of the species must be sought to explain extreme structural divergence.

The interrelation, both as to behavior and structure, between the parasite and the host becomes more perfect as the symbiosis grows more intimate. The true parasite and its host represent a type of machine with all its parts functioning coordinately, hence it is difficult to discuss the behavior of the former without also dwelling on the behavior of the latter. The stage in this relationship when the former cannot exist without the latter is certainly reached in many instances, but one may well wonder whether the reverse condition is ever actually achieved through the agency of parasitism. There are enough folks who believe that bots are a sign of health in a horse and that a dog must have fleas to keep his mind off the fact that he is a dog.

[9]Malloch, J. R. 1913. The insects of the Dipterous family Phoridae in the United States National Museum, Proc. U. S. Nat. Mus., vol. 43, pp. 411–530, pls. 35–41.

In the case of insects which suck the blood of human beings, one is impressed with the large degree of tolerance that is manifested toward those species which are wholly or largely dependent on man, no doubt immunity is an important factor, and in turn one wonders just how far the parasite has gone in making its blood-lust less offensive. Thus several extreme cases will illustrate what I mean. Gilbert Islanders with whom I spent some time during the summer of 1924 will smilingly hand you a few head lice on request, but prefer keeping them for festive reasons. The body louse to an old timer is not so offensive as a tenderfoot and many are the weird trench stories told by soldiers concerning narrow escapes from death and the tender return of a cootie to its warm nest (and to think that I was in the delousing business). Many a negro soldier, when I asked him how long he had been infested with crab lice said he guessed he always had 'em, boss. Now contemplate for a moment the very serious side of the louse question,—the louse is a vector of the deadly typhus fever and other diseases.

The bite of *Anopheles maculipennis* is benign, the bite of *Aedes dorsalis*, a common salt marsh species is viciously irritating. The former species has become largely domesticated and is a potent vector of the causative organism of malaria, the latter is a wild species. Although there will be many objectors, I believe the bite of a bed bug is less irritating than the bite of a dog flea, and I am inclined to believe that the bite of the rat flea, *Ceratophilus fasciatus*, is less irritating than that of *Pulex irritans*. The bite of *Triatoma protracta* is positively terrific, and one is inclined to suggest that this species must first moderate its bite before it can become a successful disease vector. Besides adaptations of mouthparts to piercing and bloodsucking, and apparent moderation of venoms to lessen pain in the host, there is the interesting chemical factor which prevents blood coagulation. This factor is particularly well developed in the blood sucking helminths such as the leeches and hookworms.

These chemical phenomena such as irritants and anti-coagulants can hardly be separated from toxic effects on the host such as urticaria following the bite of *Triatoma protracta*, and certain paralyses traceable to *Dermacentor venustus*, also toxic symptoms traceable to hookworms.

Free living insects which are parasitic in their larval stages manifest a very keen sensory adjustment in order to locate the host and particularly to locate it in its proper stage and at a proper time. This would appear to be particularly necessary in the case of the egg parasites. Brues[10] reports an interesting method which results in eliminating

[10]Brues, C. T. 1917. Adult hymenopterous parasites attached to the body of their host. Proc. Natl. Acad. Sci., vol. 3, pp. 136–140 (Feb. 1917).

some of these difficulties. A number of cases are known in which minute insects and arachnids are carried by another larger species presumably as "a convenient vehicle for migration." The case reported by Brues is that of a small Scelionid, *Lepidoscelis viatrix* Brues, which parasitizes grasshopper eggs, and as an adult clings by its mandibles to the abdominal segments of the wingless Deccan grasshopper, *Colemania sphenarioides*. Thus when the female grasshopper deposits its eggs it is assumed that the parasite simply seizes the opportunity and likewise oviposits. It would be interesting to know whether the Scelionids use only the female grasshopper as a carrier and also what happens to the former after oviposition. Brues remarks that "it seems strange that the same method has not been adopted by other egg parasites. Possibly other large insects do not lend themselves so readily to this purpose. . . . Winged species might easily disturb the parasites which cling only by their mandibles, and on account of their rapid movements might more easily evade the parasites."

The value of the tropisms to a parasite in securing contact with its host is well illustrated in the case of the nematode worm, *Agamermis decaudata* Cobb, Steiner and Christie, a parasite of grasshoppers and other insects. Concerning this species, Cobb, Steiner and Christie[11] write, "These free-living larvae can exist in soil for several months, during which time experiments have shown them to be apogeotropic and positively phototropic, rheotropic, pedotropic, and xenotropic. Within the limits of the vernal temperatures of arable soils in subtemperate regions, the larvae are positively thermotropic. Once dried they die. From what has been previously said concerning the deposition of the eggs, it will be seen that these tropisms tend to bring the larva to the surface of the ground and into contact with its host."

Correlation between the life cycle of a parasite and its host is obviously necessary, yet one is astonished at the remarkable adjustment existing between the gregarine *Schneideria metamorphosa* and the Mycetophilid fly, *Sciara coprophila*, as reported by Nowlin.[12] Here the "parasite changes in form *pari passu* with the changes in the host during metamorphosis."

An interesting effect that a parasite may have on its host is shown in the case of *Linguatula rhinaria* (Pilger) which occurs as a larva encysted

[11]Cobb, N.A., Steiner, G. and Christie, J. R. 1923. *Agamermis decaudata* Cobb, Steiner and Christie; a nema parasite of grasshoppers and other insects. Jour. Agric. Res., vol. XXIII, no. 11, pp. 921–926 (March 17, 1923).

[12]Nowlin, Nadine, 1922. Correlation of the life history of a parasite with the metamorphosis of its host. Jour. of Parasitology, vol. 8, no. 4, pp. 153–160, 6 pls.

in the liver of its intermediary host, e.g., the rabbit and is during that time of little consequence, but as it develops it begins to migrate, perforating the liver and causing the host to become sick when it easily falls a prey to the dog, fox or wolf or even man in whose nostrils the tongue worm reaches sexual maturity. Whether this case has its parallel in certain Mermithids is perhaps a question, but nevertheless one frequently finds dead or dying grasshoppers clinging to weeds at the edge of pools of water in which mermis occur. Examination of such grasshoppers has shown them to have been parasitized, holes from which worms had emerged being present. This inference is, of course, only a crude conjecture but I have often thought that possibly the parasite in its advanced state was a large factor in causing the sick host to seek water, thus enabling the parasite to reach a more favorable environment for its sexual maturity and propagation. On the other hand this may be but a pure coincidence.

Changes in the secondary sexual characters of the host due to parasitism have been reported by various observers as reviewed by Potts.[13] Thus various species of decapods when parasitized by *Sacculina* undergo definite changes, e.g., development of abdominal swimmerets and breadth of abdomen in the male which represent adaptations of the female to care for her brood. In the case of spider crabs at least according to Potts, "the reverse change never occurs, so that for instance a crab which on dissection showed purely female glands has never been found to have developed even a rudimentary copulatory style or to assume a swollen chela."

Entomologists are acquainted with the alteration of external secondary as well as primary sexual characters of certain Hymenoptera when stylopized. Pierce[14] in addition to alterations just suggested lists the following effects on the host due to stylopization, viz.: (1) possibility of both the race of host and parasites becoming exterminated, (2) loss of vitality, (3) acceleration or retardation of development, (4) alteration of general features such as abdomen, head, color, villosity and punctuation, indeed "stylopization may so change a species that it cannot be identified unless one understands the direction of the changes under such conditions. . . . A stylopized male or female is a male recovering the

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[13]Potts, F. A. 1909. Some phenomena associated with parasitism. Parasitology, vol. 2, pp. 42–56.

[14]Pierce, W. D. 1909. A monographic revision of the twisted winged insects comprising the order Strepsiptera Kirby. U. S. Natl. Museum, Bul. 66, pp. 124–232, figs. 1–3, pls. 1–15.

characters of the female, or a female borrowing the attributes of the male."

In preparing this paper on the effects of parasitism, it has been my object to treat the subject from a general zoological viewpoint, bearing fully in mind that the student of animal parasitology, medical entomology and biological control may become decidedly provincial in his attitude. It would not be entirely out of place to discuss the effects of parasitology on the student. Furthermore, in order to provoke criticism and discussion of certain points concerning which I am not clear myself, I have purposely made broad statements in several instances without, perhaps, sufficient supporting evidence.

If one were to tabulate the several qualifications which a species must possess in order to become a successful parasite, it would soon become apparent that all successful species, whether free living or parasitic are endowed with these same fundamental qualities. Parasitism does not operate under laws of its own, but under laws fundamental to the life of all animals. Modifications of structure and behavior commonly attributed to parasitism may be found in certain other animals as well, for example, suckers and other adhesive organs occur in flukes, tapeworms and the like and also in the ship barnacle (*Balanus*), and the mussel (*Mytelus*) among many others,—in the one case these organs provide a means of holding fast to another object while travelling swiftly through the feeding environment and in the other case, stationary anchorage to substrata also in a feeding environment is afforded where otherwise these animals would be dashed to pieces or washed into slack water.

As stated in the beginning, the study of parasitism is fascinating, its interpretations are dangerously full of pitfalls, adaptations to this mode of life both on the part of the parasite and the host are amazingly subtle, yet in it all may be seen the manifestation of laws which govern all living things.

CHAIRMAN GEORGE A. DEAN: These splendid papers are now open for general discussion.

(Due partly to the lateness of the hour in finishing the afternoon's program, there was no discussion.)

ADJOURNMENT: 4:40 p. m.

Section of Plant Quarantine and Inspection

Tuesday Morning, December 29, 1925

The Section of Plant Quarantine and Inspection of the American Association of Economic Entomologists was called to order at ten-fifteen o'clock at the Kansas City School of Law, Kansas City, Missouri, December 29, 1925, by Mr. E. N. Cory.

CHAIRMAN CORY: It was with a great deal of regret that we learned this morning that owing to sickness in his family Mr. Hadley is unable to be present. I have been asked to act in his place. I am sure we all, as an Association and personally, feel the loss of Mr. Gossard, and later on I think it would be appropriate for us to voice some expression of that regret.

I am going to appoint on the Committee on Nominations, Mr. E. R. Sasscer, Mr. Richard Faxon and Mr. G. H. Arnold.

The first paper is by C. L. Marlatt of Washington, D. C.

RECENT WORK OF THE FEDERAL HORTICULTURAL BOARD

By C. L. MARLATT, *Washington, D. C.*

(Not submitted for publication)

CHAIRMAN CORY: The next paper is by L. A. Strong.

THE LEGAL ASPECT OF PLANT QUARANTINES

By L. A. STRONG, *Sacramento, Calif.*

ABSTRACT

No case dealing with plant quarantine has been carried to the U. S. Supreme Court. Numerous animal quarantines have been taken to the U. S. Supreme Court where decisions have been rendered and inasmuch as plant quarantines are promulgated and enforced on the same principle as animal quarantines, it may be assumed that plant quarantines, if carried to the U. S. Supreme Court for decision as to constitutionality, would be decided on the same precedents and on the same principles as have governed the decisions with respect to animal quarantines. The nearest approach to a final and conclusive decision of the constitutionality of a plant quarantine is the case of the Oregon-Washington Railroad and Navigation Company v. the State of Washington, tried in the State Supreme Court of Washington.

Various U. S. Supreme Court decisions point out that the prevention of disease is the essence of the quarantine law. A statute for the regulation of commerce under the guise of an inspection law cannot be upheld but must be condemned. While a state may not legislate for the direct control of interstate commerce, it may exercise any part of the legislative power which is not withdrawn from it by the scheme of

government put into operation by the Federal Constitution. A law passed in pursuance of the acknowledged power of the state may have an indirect effect upon interstate commerce. Such a law, though it is essential to its validity that authority be found in governmental power entirely distinct from the power to regulate interstate commerce, may reach and indirectly control that subject. In the application of the principle of supremacy of an Act of Congress in a case where the State Law is but an exercise of the reserve power, the repugnance or conflict should be direct or positive so that the two acts could not be reconciled or stand together.

The disadvantage of discussing such a subject as "The Legal Aspect of Plant Quarantines" is obvious since there have been, so far as I have been able to find, no cases dealing with plant quarantine carried to the U. S. Supreme Court which is the Court of last resort in establishing the legality of any plant quarantine or other act. There have been numerous cases of animal quarantines taken to the U. S. Supreme Court where decisions have been rendered and inasmuch as plant quarantines are drawn and enforced largely along the same lines as animal quarantines, we may assume that plant quarantines if brought before the U. S. Supreme Court for decision as to constitutionality would be decided on the same precedents and the same principles as have governed the decisions with respect to animal quarantines.

Perhaps the nearest approach to a final and conclusive test of the constitutionality of a plant quarantine is the case of the Oregon-Washington Railroad & Navigation Company vs. the State of Washington, which was tried in the State Supreme Court in the State of Washington. The Director of Agriculture of the State of Washington issued a quarantine prohibiting the movement into the State of Washington of alfalfa hay and certain other commodities from the State of Utah, certain portions of the states of Idaho, Wyoming, Colorado, Oregon and Nevada on account of the prevalence in those areas of alfalfa weevil. The Oregon-Washington Railroad & Navigation Company violated this quarantine by bringing alfalfa hay from the quarantined area into the State of Washington for trans-shipment through the State. While there was a penalty provided in the basic act under which the quarantine was issued for violation of any quarantine drawn thereunder, the Director of Agriculture, acting probably on the legal advice of the Attorney General, sought an injunction restraining the Railroad Company from shipping into the State or through the State except in sealed containers, any alfalfa hay from those areas quarantined against by the quarantine order. This action was brought in the Superior Court, which Court granted the permanent injunction.

The Railroad Company then appealed the case to the state Supreme Court, the grounds for the appeal being briefly as follows:

First, that the quarantine order was in violation of Paragraph 8 of Article 1 of the Constitution of the United States insofar as that Section gives to Congress the power "to regulate commerce among the several states." The argument was based apparently on the assumption that because the quarantine order absolutely prohibits bringing into the State any alfalfa hay from the territory against which the quarantine order runs, it is in effect an unreasonable and unwarranted interference with interstate commerce. The Railroad Company conceded that the State could establish reasonable regulations looking to the inspection at the state line of commodities about to enter the state, with the view to excluding those found to be infected in such manner as to endanger persons and property in the state, but contested the right of the state to determine that certain territory outside the state is so afflicted with alfalfa weevil that no alfalfa hay coming from such territory can be safely allowed to come into the state because of the probability of the alfalfa crops of Washington becoming infected in the same manner and thereby seriously damaged.

Second, it was contended by the Railroad Company that the basic law of the State of Washington under which the quarantine order was drawn was rendered ineffective because of legislation on the subject matter thereof having been enacted by Congress. It was represented that such an action had resulted in superseding all exercise of the power of the state with reference to the subject matter.

Third, the Railroad Company contended that the Section of the law under which the quarantine order was issued is only an inspection quarantine law in that the Director of Agriculture was by its terms only authorized to prevent the bringing of shipments of alfalfa hay within the state upon specific inspection of each particular shipment at the state line and a determination that such shipment is infected to the extent of warranting its exclusion, and is not authorized to exclude all shipments solely because of their coming from territory without the state against which the quarantine order runs.

Fourth, it was contended that the quarantine order was without effect because not properly promulgated or evidenced to the public by proclamation of the Governor.

Fifth, it was represented that the quarantine order was issued without proper investigation and that it is an unreasonable exercise of the police power of the State.

In support of their contention that the quarantine order was in violation of that Section of the Constitution of the United States which

gives to Congress the power to regulate commerce among the several states there was cited the case of Railroad Company vs. Husen which was decided by the U. S. Supreme Court. In that case there was brought into question a statute of the State of Missouri prohibiting the bringing into that state of certain kinds of cattle as follows:

"No Texas, Mexican, or Indian cattle shall be driven or otherwise conveyed into or remain in any county in this state, between the first day of March and the first day of November in each year, by any person or persons whatsoever."

The Washington State Supreme Court held that this statute was different from the Washington State Quarantine order in that the Missouri statute did not pretend to define any outside territory quarantined against; nor did it pretend to differentiate between cattle afflicted with contagious or infectious diseases and cattle that were not so afflicted. This particular Missouri statute was held by the U. S. Supreme Court as void as an attempted interference with interstate commerce. Speaking with respect to this Missouri case the Justice of the U. S. Supreme Court made the following statement:

"Many acts of a State may, indeed, affect commerce, without amounting to a regulation of it, in the constitutional sense of the term, and it is sometimes difficult to define the distinction between that which merely affects or influences and that which regulates or furnishes a rule for conduct. There is no such difficulty in the present (Missouri) case. While we unhesitatingly admit that a State may pass sanitary laws, and laws for the protection of life, liberty, health, or property within its borders; while it may prevent persons and animals suffering under contagious or infectious diseases, from entering the State,— while for the purpose of self-protection it may establish quarantine, and reasonable inspection laws, it may not interfere with transportation into or through the State, beyond what is absolutely necessary for its self-protection. It may not, under cover of exerting its police powers, substantially prohibit or burden either foreign or interstate commerce.

"Tried by this rule, the statute of Missouri is a plain intrusion upon the exclusive domain of Congress. It is not a quarantine law. It is not an inspection law. It says to all natural persons and to all transportation companies, 'You shall not bring into the State any Texas cattle or any Mexican cattle or Indian cattle, between March 1 and November 1 in any year, no matter whether they are free from disease or not, no matter whether they may do any injury to the inhabitants of the State or not; and if you do bring them in, even for the

purpose of carrying them through the State without unloading them, you shall be subject to extraordinary liabilities.' Such a statute, we do not doubt, it is beyond the power of a State to enact. To hold otherwise would be to ignore one of the leading objects which the Constitution of the United States was designed to secure."

The Washington State Supreme Court held that the quarantine order issued by the Washington State Director of Agriculture and the law under which that quarantine was issued differed from the Missouri law which was declared unconstitutional, citing several other cases dealing with animal quarantines which had been before the U. S. Supreme Court, notably the case of Rasmussen vs. Idaho, and Smith vs. St. Louis and Southwestern Railway Company.

The Washington State Supreme Court held that in these cases there had been established these general propositions; first, the State has the power to exclude from its territory without specific inspection at the state line the whole of any commodity sought to be brought into the state from a territory which its duly constituted authority has, in pursuance of its law, found to be so afflicted with blight or disease as will probably, by the bringing of the given commodity into the state, result, by infection, in material injury to a considerable portion of the property within the state, especially when such property liable to be so infected is in a relatively large measure one of the resources of the state.

Second; such finding and decision of the duly constituted authority of the state, made as provided by its law, is prima facie sufficient to support such exclusion of the given commodity coming from any portion of such territory, and that the burden of showing otherwise rests upon the one who attacks the validity of such determination insofar as the invalidity of such determination is rested upon alleged insufficient facts to support its reasonableness. Viewed in the light of the allegations of the complaint above quoted and this presumption, we think the finding, decision and quarantine order of exclusion with reference to shipments of alfalfa hay originating in the territory quarantined against, is not in violation of any of the appellant's rights claimed under the commerce clause of the federal constitution.

In other words, it seemed to be the judgment of the Court that the State has the right when dealing with a pest of the nature of the alfalfa weevil which threatens to injure one of the state's resources to define certain quarantined territory in other states and to prohibit absolutely the shipment from that territory of infected material or material suspected of being infected into the State; that a blanket quarantine of

this nature drawn for the purpose of excluding pests and not for the purpose of regulating commerce is not in violation of the Constitution of the United States even though the effect of the quarantine may be in some measure to regulate or influence commerce.

In support of the second contention that the law under which the quarantine was drawn was rendered ineffective because of legislation upon the subject matter thereof having been enacted by Congress, there was quoted Paragraph 8 of the Plant Quarantine Act passed by Congress August 20, 1912, as amended by the Act of March 4, 1917. The Section quoted authorizes the Secretary of Agriculture to quarantine any state, territory or district of the United States or any portion thereof when he has determined that such quarantine is necessary to prevent the spread of a dangerous plant disease or insect infestation new to or not heretofore widely prevalent or distributed within and throughout the United States. In support of this contention the Railroad Company cited a case which had been decided by the U. S. Supreme Court, Missouri Pacific Railway vs. Larabee Mills Company. In this case apparently the State of Kansas had certain local railway switching regulations which the Missouri Pacific Railway Company contested in view of the fact that the interstate commerce commission had been authorized by Congress to place such regulations, and even though they had not placed the regulations, the Missouri Pacific Railroad contended that inasmuch as Congress had entrusted the powers of regulation to the interstate commerce commission the state was prevented from taking action looking to a local regulation.

Mr. Justice Brewer, speaking for the U. S. Supreme Court, stated among other things, "the fact that Congress has entrusted the power to the interstate commerce commission does not, in the absence of action by it, change the rule which existed prior to the creation of the commission. Congress could always regulate interstate commerce, and could make specific provisions in reference thereto, and yet this has not been held to interfere with the power of the State in these incidental matters. A mere delegation by Congress to the commission of a like power has no greater effect, and does not of itself disturb the authority of the State. In other words, the mere grant by Congress to the commission of certain national powers in respect to interstate commerce does not of itself and in the absence of action by the commission interfere with the authority of the State to make those regulations conducive to the welfare and convenience of its citizens. Until specific action by Congress or the commission the control of the State over these incidental matters remains undisturbed."

The Washington State Supreme Court in discussing the contention of the Oregon-Washington Railroad & Navigation Company that the passage by Congress of the Plant Quarantine Act had taken from the State the right to act in the matter of plant quarantine, made the following statement: "It seems to us that just as the interstate commerce commission had not assumed to act with respect to the local matter incident to the interstate commerce there drawn in question, and that therefore the Federal government had not assumed to act with reference thereto; so the Secretary of Agriculture of the United States has not assumed to act under Section 8760 above quoted with reference to the preventing of the possible spread of the alfalfa weevil as a pest, and that therefore the Federal government has not assumed to act with reference thereto. We are of the opinion that the Federal government has not assumed control of the subject matter in question to the exclusion of state authority with reference thereto."

With respect to the third contention that the law was an inspection quarantine law and only authorized the Director of Agriculture to prevent the bringing of shipments of alfalfa hay into the state upon a specific inspection of each particular shipment, etc., the Washington State Supreme Court held that inasmuch as the Director of Agriculture upon the approval of the governor is given power under the State law to "maintain and enforce such obligatory quarantine regulations as may be deemed necessary to protect the forest, agricultural, horticultural, ornamental and floral trees, shrubs, and plants, and the products thereof in the State of Washington, against contagion or infestation by injurious plant disease insects, this is a sufficiently broad power to enable the Director of Agriculture, with the approval of the governor, to exclude entirely, without the necessity of specific inspection at the state line of each particular shipment, the bringing into the state of alfalfa hay from territory outside the state infected with alfalfa weevil as found, decided and ordered."

Referring to the fourth contention that the quarantine was without effect because not properly promulgated or evidenced to the public by proclamation of the governor, the State Supreme Court held that the signing of the order by the Director of Agriculture, the governor's approval by signature and the filing of the quarantine in the office of the Secretary of State was in any event a sufficient proclamation of it by the governor to render it valid and effective.

In disposing of the contention that the quarantine had been issued without sufficient investigation, the case of Railroad Company vs.

Husen was cited in which decision Mr. Justice McKenna of the U. S. Supreme Court states; "The presumption which the law attaches to the acts of public officers must obtain and prevail." He further states: "The presumptions of the law are proof." If I interpret this correctly, the U. S. Supreme Court holds that the court and the law will assume that a public officer has acted in full accordance with the terms of the law until proof to the contrary is shown.

The State Supreme Court affirmed the decision of the trial court which granted a permanent injunction against bringing into the State by the Oregon-Washington Railroad & Navigation Company of alfalfa hay from those areas placed under quarantine by the Director of Agriculture of the State of Washington.

In summing up briefly, the points which have been clearly brought out in various animal quarantine cases brought before the U. S. Supreme Court, and which seem most important in the consideration of the legal aspects of Plant Quarantines are somewhat as follows.

In the case of Railroad vs. Husen, the U. S. Supreme Court emphasizes that the prevention of disease is the essence of a quarantine law. Such law is directed not only to the actually diseased but to what has been exposed to disease. Quoting from the Supreme Court of Tennessee: "The necessities of such cases often require prompt action. The end to be attained by the exercise of power to declare a quarantine may be defeated and irreparable injury done."

In the case of Minnesota vs. Barber; Brimmer vs. Redman; Gulf Coast Railway Company vs. Hefley and Lewis; the U. S. Supreme Court held that a statute for the regulation of commerce under the guise of an inspection law cannot be upheld but must be condemned.

In the case of Asbell vs. the State of Kansas, the U. S. Supreme Court held that though it might not legislate for the direct control of interstate commerce, the State may exercise any part of the legislative power which was not withdrawn from it by the scheme of government put into operation by the Federal Constitution. It may sometimes happen that a law passed in pursuance of the acknowledged power of the state will have an indirect effect upon interstate commerce. Such a law, though it is essential to its validity that authority be found in governmental power entirely distinct from the power to regulate interstate commerce, may reach and indirectly control that subject. In this same case it was held to be obvious that any exercise of state authority, in whatever form manifested, which directly regulates interstate commerce is repugnant to the commerce clause of

the Constitution. In the case of Sinnot vs. Davenport, the U. S. Supreme Court held that in the application of this principle of supremacy of an act of Congress in a case where the state law is but the exercise of the reserved power, the repugnance or conflict should be direct or positive so that the two acts could not be reconciled or stand together.

In the case of the Missouri Pacific vs. Larabee Mills Company, the U. S. Supreme Court held that until specific action by Congress or the commission, the control of the state over these incidental matters remains undisturbed.

It would seem therefore that with respect to constitutionality of state quarantines, if they are drawn on the principle of preventing the entry of diseases or pests and promulgated under authority found in governmental power entirely distinct from power to regulate interstate commerce, and if the limits of the quarantined area are definite and the commodities quarantined against named and shown to be potential menaces to the state issuing the quarantine, that they would be constitutionally sound.

While I have no direct information in support of such a statement, it would seem reasonable to suppose that a federal quarantine directed against a foreign country drawn in accordance with the terms of the enabling act could not be questioned except it came into direct conflict with a treaty with a foreign power. It would seem from the many U. S. Supreme Court decisions which have been rendered with respect to quarantines that there could be no question of the constitutionality of federal quarantines issued against portions of the United States if the quarantines are issued in conformity with the enabling act, since the power of Congress to regulate commerce with foreign nations and among the several states is clearly emphasized in the Constitution.

CHAIRMAN CORY: The next paper is by Mr. Becker.

THE LEGAL SIDE OF REGULATORY WORK

By GEO. G. BECKER, *Chief Inspector, State Plant Board of Arkansas, Little Rock, Ark.*

ABSTRACT

Since inspection and quarantine laws are seldom invoked in the courts of the average state, success in getting prosecutions will be largely measured by the amount of assistance the inspector can give judges and prosecuting attorneys through his familiarity with the legal phases of the cases to be brought up. Information which will facilitate the drawing up of indictments, charging of juries, etc., with the least loss of time on the part of prosecuting attorney and judge will be especially valuable.

Once a year members of the Association who are interested in horticultural inspection discuss various events or development which are of entomological interest after which we return to our respective states to work out, individually, the big administrative problems which have to do with our contact with legislatures, juries, judges, prosecuting attorneys, etc.

In attempting to get legal enforcement of their regulatory work, plant inspectors and quarantine officers are not long in finding out that bringing a violator of quarantine or inspection laws to the bar of justice is more than merely reporting the matter to a prosecuting attorney and awaiting the time to be subpoenaed to appear before a judge or jury. As a matter of fact, and this applies particularly to projects to which there is opposition, it may require a year or two before the stage is properly set for a prosecution. Attempt is made in this paper to present a few conclusions derived from experience in carrying out regulatory work in Arkansas, an average state, with the hope that it will open up discussions on this important part of our work which we have heretofore refrained from discussing.

For the convenience of this paper the subject matter will be discussed under four heads as follows: (1) complying with law requirements, (2) legal extension work, (3) preparing for prosecution and (4) the evidence.

Complying with Law Requirements

Most of our inspection and quarantine laws have various requirements to be met as a condition for properly promulgating regulations. Hearings, with due public notice, may be required and public notice of promulgation may be necessary. In the absence of a specific procedure being outlined in the inspection law for the promulgation of public notices one will, of course, be guided by the provisions in the statutes of one's state. As to what constitutes a properly promulgated public notice will depend upon the laws of the state concerned. Where a public notice is given to a reporter and the same is carried verbatim in a newspaper story the courts will generally consider this as news and not as a properly promulgated notice. Usually a paid notice must be run, and the paper selected for the notice will naturally be a medium of general circulation which will reach the class of people affected by the notice.

Legal Extension Work

In Arkansas we have found that effectiveness in legal enforcement of our regulations may be much hampered by a lack of extension work

with judges, prosecuting attorneys, influential lawyers and with influential officials such as county judges, sheriffs and others to whom people go so often to find out whether such and such is lawful or unlawful. It has been our experience that this can best be done through influential farmers, bankers and others who can impress the officials with the fact that the laws or regulations in question are vital for the protection of the agricultural interests of the county. Judges and prosecuting attorneys like to know that the laws which are to be invoked are of real importance to the community which they serve and that they are not the result of "peanut" politics. With such preliminary extension work done the inspector will have some assurance of a receptive attitude when he takes up the matter of prosecutions with judge and prosecuting attorney. To realize the importance of extension work of this type one need only remember that a judge, in the selection of his jury commissioners, can practically lose a case before it is tried, and if this is not enough he can do as much or even more harm to the cause when he gives his charge to the jury. Likewise a prosecuting attorney can render nil one's efforts with a grand jury by forgetting to write up an indictment which one may have labored hard to get.

The administration of regulatory work can, of course, be greatly facilitated by freely calling upon the attorney general not only for interpretations and opinions of laws and regulations but also for legal advice on the general administration of the work. Aside from the valuable assistance which the inspector gets in this manner the opinions and interpretations rendered will have a publicity value which will impress the public with the importance of the work. We have gotten the best service from the attorney general's office by asking to be assigned to the same assistant for all opinions and advice on the work.

Preparing for Prosecution

Where plans are being made to make a test of a law, rule or regulation in the courts one will, of course, give some thought to the matter of selecting the violator to be prosecuted. A case will never be appealed to the supreme court unless the defendant is obstinate enough to want to see the thing through. When our board got ready to test out its regulations for the first time we were advised by the then attorney general to pick out the meanest, most hard-headed and most "hard-boiled" violator we could find.

Most inspection laws require that written notices be served before one can prosecute a violator. This notice will likely be the most important

piece of evidence submitted in the trial. It can be prepared with such thoroughness and thought, and can cover the facts in the case so fully as to almost force the case to be tried on technicalities. In our notices we cite not only the authority for serving the notice but also the provisions of the laws, rules, or regulations which are invoked. For example a cedar rust notice sets forth that an inspection was made on a certain day by a certain inspector, and then gives the findings of the inspector. The person is advised of the exact location of the premises and that they are in an area declared by the board to be territory in which cedar rust has been declared a public nuisance. He is advised that the trees in question are red cedar trees, that they are infected with cedar rust, that they are within a mile and a half of an apple orchard, and that they are standing in violation of the provisions of our Rule 51. The Arkansas plant act, as with most other inspection laws, limits authority to dealing with infested or infected plants or plant products. Hence it is always necessary for us to make clear that the condemned products were inspected and found diseased or infested. A reasonable time is always given in the notice for complying with its provisions.

Where the method of serving written notices is not specifically set forth in the inspection law one will follow the method prescribed in the statutes of the state concerned. In Arkansas written notices are served by the sheriff. The latter is given the notice in duplicate. He leaves the duplicate with the person on whom it is served and returns the original to us with a sworn statement at the bottom setting forth the fact that it was served on and the substance thereof explained to the addressee, giving date and place of serving. Generally a statement of fees collected from the Board for serving the notice is given.

While it is usually a simple matter for a lawyer to decide what court will have jurisdiction over a case to be presented it has been our experience that a prosecuting attorney may be careless on this point. There is usually no doubt as to jurisdiction in cases which have to do with eradication work but where nursery regulations or quarantines are involved the prosecuting attorney may have to go into this very thoroughly. Usually jurisdiction will be as of point from which the products were shipped but where nurserymen have agents out over the state venue may be at point of delivery.

The statute of limitations for beginning prosecutions for various offenses varies in the different states. Our inspection law defines violations as misdemeanors and since, under our statute of limitations, an

indictment for a misdemeanor must be secured within a year of the time when the offense was committed it is important that the matter of making inspections and serving notices take this into consideration.

In Arkansas, and doubtless in other states where there have been few prosecutions under the plant inspection laws, considerable difficulty may be experienced in getting the prosecuting attorney to write up an indictment. Prosecuting attorneys have their hands full during court. While they can all write up indictments for murder, bootlegging or rape without much thought on the subject most of them are unfamiliar with the inspection laws and are loath to take up the time to study the law on the subject. It is our practice to always communicate with a prosecuting attorney some weeks in advance of the time when we expect to bring up a case which will come under his jurisdiction and to supply him with copies of laws, rules and regulations having bearing on the case. Once a case has been tried one may use the indictment form for similar cases which may come up in the future. It would be of inestimable value to prosecuting attorneys and would be highly appreciated if one could have three or four indictment forms drawn up which would cover most of the cases which would likely be brought up under the laws which are being administered.

It has been our experience that regardless of the number of precautions which the inspector has taken he cannot take it for granted that he has secured an indictment after the grand jury has acted favorably on the case reported by him. It may sometimes require considerable effort on the inspector's part to keep a prosecuting attorney from forgetting the case and letting the grand jury adjourn without having written up the indictment.

The judge as well as the prosecuting attorney will want to be thoroughly acquainted well in advance with the provisions of the laws to be tried out in his court, in order that he may have plenty of time to study the points of law so that he can instruct his jury properly, as well as preparing himself to make decisions on points which the attorneys are likely to bring into question.

Where there is going to be opposition to a case efforts are, of course, always made to have it brought to trial at a term of court when it appears that the jury is most likely to give it a fair trial, for it should be remembered that, in the absence of an instructed verdict, the State, if it loses a case, cannot appeal it unless the constitutionality of the law or validity of a regulation is involved.

The Evidence

Every inspector knows that when his case is brought to trial he will be called upon to prove every statement he makes and that the case is more likely to be tried on technicalities than on whether or not a notice from an inspector was ignored.

If rules or regulations are involved it will have to be shown that they were actually made and duly promulgated in the manner prescribed by law. Official records will have to be produced or in lieu of the actual records certified copies will have to be submitted by the person recognized under the law as competent to certify to this information. As we all know, this person will not likely be the inspector.

If hearings are involved, evidence will have to be introduced to show that they were duly advertised and held. Authenticity of public notices will have to be established and affidavits from publishers submitted to show proper promulgation through a proper medium. The inspector may even have to introduce evidence to show that he is the duly authorized chief inspector or state entomologist.

Evidence will have to be introduced to show that notice was served on the defendant as required by law, and of course, the notice itself will be produced. Mention has already been made of precautions which we take in the framing of this notice with a view to bringing out just such information as will be needed at the trial.

We have found it desirable to introduce in evidence diseased trees or plant products, when possible, to show that the condemned trees or plants were diseased or infested. In a well contested case one may need disinterested expert testimony to verify statements or findings of the inspector.

As inspectors we are all familiar with the fact that there are many points which must be considered to see to it that the prosecuting attorney lacks nothing to have complete evidence for the case to be tried. Attempt is made here not to enumerate these points but to emphasize the fact that many details must be looked into and that the prosecuting attorney will generally take it for granted that the inspector will have this evidence.

Conclusions

In conclusion, it should be said that the state inspector of the average state finds it necessary to be well informed not only on the provisions of the law which he administers but also on other statutory law, and on the provisions of the Common Law, which may have bearing on his proper administration of the regulatory work in his charge. In addition to

this his success in getting prosecutions will be measured by the amount of assistance he can render prosecuting attorneys and judges with whom he comes into contact. Opinions from attorney generals, references to court decisions in his own or other states, information to facilitate drawing up indictments, etc., will be greatly appreciated by prosecuting attorney and judge alike.

CHAIRMAN CORY: These two papers on legal aspects of regulatory work are open for discussion.

MR. C. L. CORKINS (Wyoming): There is one legal phase of plant quarantine work which has not been touched upon this morning which is of vital concern at the present moment in the State of Wyoming.

As you doubtless know, we have discovered on the eastern slope of the Rocky Mountains in Wyoming the first infestation of alfalfa weevil which has been found on this side of the range. As soon as we discovered this new infested territory, we advised the quarantine entomologists throughout the United States of this new infestation. There are some states which did not impose a quarantine against our newly infested territory and we were advised by them that they expected us to prevent the interstate shipment out of this newly infested territory into their states in order that they might be protected, in other words, asking us to protect them, even in the event that they did not promulgate a quarantine against us. I should like to ask if it is possible for a state entomologist to so interfere with interstate commerce? Is it possible for us specifically in Wyoming to say, when there is not a quarantine against us by some such state, let us say, as New York, that our shipper in Douglas, Wyoming, inside the infested territory, can not bill out a carload of hay to New York City?

MR. STRONG: I should think it would not be possible for the State of Wyoming to have any control at all over shipments out of the State. It is up to the state outside to place its own quarantine and prohibit shipments from entering. You can however, prevent shipment from one part of the state to another part of that same state.

MR. F. N. WALLACE: I can't see why he can't prohibit the shipment of alfalfa out of that district. I know I could in Indiana. Of course it has never been taken up with the supreme court, but I know our law covers that. We can absolutely prohibit it.

MR. STRONG: I think, Mr. Wallace, you could prohibit it in so far as protecting any other portion of your state is concerned, but to

interfere with the interstate movement of a commodity out of your state, I don't believe there is any law in any state that will permit that. I think it is up to another state to prevent its coming in; I don't believe there is a law that will prevent its going out.

MR. WALLACE: We did, and it was never questioned. We absolutely stopped the shipment of everything that was going out of the state. We quarantined the elevators that had wheat in them. The Federal Horticultural Board said we had to. They said, "If you don't, we will," and we didn't want them in Indiana.

MR. W. J. SCHOENE: I didn't think there was any question that any state could quarantine any section of the state either to points within the state or points without the state. The only question a man has to decide is whether he can do it and hold his job. If he has no quarantine against his area and he arbitrarily places a quarantine, the people within his own state may put him out of office. I don't think there is any question about the authority; I believe any state officer can quarantine any portion of the state against any other portion of his own state, and I think he can prevent the movement of any infested or suspectedly infested commodity in that area if he can show there is danger to any other part of the state by movement through any portion of his state, but I don't believe there is a law in any state that will give you authority to quarantine a portion of your state and prevent the shipment of a commodity out of that area to some other state. You are dealing with interstate commerce. You can deal with intrastate commerce to the limit, but when it comes to interstate commerce it is a different matter.

MR. S. B. FRACKER: In the State of Wisconsin, authority is given the department to prevent the removal of any private or public property from any area of the state which in it's judgment contains dangerously infested material of any kind. In that case the matter is purely a local one and is determined on the basis of a local infestation. On that basis we refused to certify white pine trees from perhaps twenty counties of the state, the general area which is infested with the white pine blister rust, even though the shipment was destined to states which had no quarantine against Wisconsin, in the absence of a federal quarantine on the subject.

I should like to ask Mr. Strong whether he will go further than he has so far and state whether a provision of this type is unconstitutional.

MR. STRONG: I assume that the statute was enacted to protect certain portions of your state which are not now infested, but when you deal with a commodity going to another state, you are dealing entirely with interstate commerce, not with a local matter at all. There are a lot of these regulations that will hold up in a local way within the state, but you can't apply them to interstate commerce. I don't know whether that statute is constitutional or not.

MR. MARLATT: Wouldn't it be possible to notify New York that you have a local quarantine governing the movement out of this infested territory entirely within your state and the enforcement of that local quarantine protects New York because it prevents movement out of that district? It is merely a matter of information. The quarantine wouldn't be applied to protect New York, but the operation of the quarantine would protect it.

MR. FRACKER: I should like to ask Mr. Strong, reverting to his original paper and to the case before the Supreme Court of the State of Washington, (the second point was based on the question as to whether the alfalfa weevil had been covered by Congress and the decision, as I understood it, by the court was based on the fact that the Federal Horticultural Board had not acted with respect to the alfalfa weevil), would you interpret the decision of the court to be, that if a state quarantine differs from a federal quarantine which covers the subject in part, that the state quarantine, as it differs from the federal quarantine, would be in violation of the constitution? Did the Supreme Court decision cover that point?

MR. STRONG: The Supreme Court decision states specifically that a state law must be obviously so much in conflict with a federal law that it couldn't be reconciled at all before it would be considered invalid.

There is another United States Supreme Court decision which holds that even though the federal government acts and fully covers the subject, the state law on that same subject is merely in suspension and when the federal government withdraws action, then the state law again becomes valid and takes effect. I would assume from that that if the federal law were not sufficient to protect the state fully, the state could go even further in certain lines. If the United States government certified that a certain commodity has been inspected and is free to move, then a state can't take action with respect to that certain commodity unless they take action on some other ground. But if the state law goes a little further than the federal law and is not in direct conflict, I believe it would be constitutionally sound.

MR. P. A. GLENN (Illinois): Suppose the federal quarantine covers a certain subject like the European corn borer and prescribes a certain area by townships; if the state should put on a quarantine regulating the movement of products from that part of the state which the federal quarantine does not cover, would the state quarantine be considered illegal or unconstitutional where the federal quarantine has not covered that part of the state?

MR. STRONG: When it comes to the decision of the constitutionality of an act, when it goes to the State Supreme Court or United States Supreme Court, all sentiment is set aside and they decide on the merits of the law itself. The law, only, is considered, but I should think that if the federal quarantine had not covered sufficient area to guarantee safety, you might put on supplementary regulations. I don't think that would be questioned anyway, but I should think you could take such action as would protect the remainder of your state.

MR. BECKER: Right along that point, I remember when we had that conference of inspectors at Washington to discuss the various legal aspects of quarantine, and so forth, I addressed that very question particularly to the assistant solicitor. He said when the federal government, through a regulation of any kind, had covered a certain subject—we will take this European corn borer—that that presupposes the subject has been covered by the federal government. I brought up the question, that if investigations of the state proved it would be desirable to supplement the federal quarantine, would those state regulations be valid, and he said they would not. As I understand it, when such a situation arises, it will be the burden of the state, when it comes to supplement these regulations, to show in court that the federal regulations do not cover the subject; even then I am not sure that the state regulation is going to have any bearing, because the federal government is supposed, through its experts, to have studied this matter, and they say, "This is the way we see it from the standpoint of the country as a whole," that is the last word. That is my understanding.

MR. STRONG: The federal regulations only govern the interstate movement and your supplemental regulation would be a local measure for the protection of the remainder of the state. When you come to the question of the constitutionality of these things, it is a matter that is up to the court. You will find in some of these United States Supreme Court decisions three judges for and two against, and if one of those against happened to be your state attorney general, he would be giving

you the wrong information. That is the amount of dependence you can place on these attorney generals, but for local regulations, I think you could put it on because I don't think it would be questioned by any one.

MR. FARLEY: Kansas has a quarantine against alfalfa shipped in from certain counties in Wyoming, and Missouri also has a quarantine against certain counties; Missouri has a quarantine against Churchill County and Kansas has not. A shipment of a carload of alfalfa had been billed to Kansas City, Missouri, and they refused to allow them to unload it on the ground that there is a quarantine. They discovered that Kansas did not have a quarantine against that particular county, and the railroad company wanted to know if there was any reason why they couldn't unload it in Kansas City and truck it across to Kansas City, Missouri. Kansas had no quarantine against that particular county, so I saw no reason why they shouldn't unload it in Kansas. Our quarantine didn't prohibit alfalfa from Churchill County. They unloaded the alfalfa in Kansas and trucked it across the line. That is coming through the back door, and I think if Missouri had insisted on it, they could have refused admission of that hay, because it was from Churchill County, Wyoming, against which they had a quarantine.

MR. L. H. WORTHLEY (Mass.): I hardly think the case which Mr. Glenn brings up on the quarantine of the corn borer area is thoroughly understood. I believe the State of Illinois is quarantined against the entire State of Ohio. Now the corn borer infestation is much nearer the Indiana line and many of the Indiana towns are nearer corn borer infestation than those towns in the southern part of Ohio, so why quarantine the entire State of Ohio and not quarantine a part of Indiana?

We have established a quarantine line through what we believe to be competent inspection, and some of this quarantine applies to territory that is seventy-five miles outside of where an infestation exists, but the corn borer infestation in the western part of Ohio is within thirty-five or forty miles of Indiana, and there is just as much likelihood of corn borers being in Indiana as there is down in Portsmouth, Ohio, so so I don't see where they could prove, if a man from Portsmouth, Ohio, ships corn into Illinois, that they had any right to quarantine that part of it. The state regulations cover very thoroughly the area which is known to be infested, but don't cover the other part of the state, and from many indications that have come up so far, there isn't much likelihood of any infestation being in the southern part of the state.

MR. DEAN (Idaho): I believe that much contention of these inter- and intrastate quarantines is due to the fact that all states do not have

intrastate quarantine, and because of that fact, for our own protection we must quarantine the whole state, which sometimes may mean a hardship. We in Idaho have probably suffered as much from that as anyone, due to the fact that we did not have intrastate quarantine or control by county, and for that reason, the quarantine of other states was made a blanket quarantine over the entire state.

I believe it is actually necessary for the best protection, for every state to have its particular quarantine laws and regulations for their enforcement within their lines, and then the federal activities or the federal law comes in in our interstate movement of product, but we should in our own states control those matters county by county with just as much rigidity as is possible.

MR. LEONARD HASEMAN (Missouri): I am very glad this discussion has come up. In connection with a recent quarantine established by the Missouri state board against the alfalfa weevil, apparently the quarantine was made a little stricter than some of the states wanted it, and the question came up at the conference of our board recently as to whether or not, for instance, Section 13 of the Missouri Plant Act gives the state plant board of Missouri authority to prevent the movement of products out of an area which it quarantines. Our laws specifically state that it has that power, and if it is constitutional, I don't see how any one in that area could ship anything into Kansas, Wyoming or anywhere else after our board takes action.

MR. STRONG: I think that probably the reason you prevent scale infested material moving out is because if it moves out and into another state it is burned, if the states are given power to protect themselves through police power. I don't think your quarantine carries with it any authority to protect another state. If you confine any commodity to a certain locality in your state, you have got to do it because the movement out of that state would endanger some other portion of your state. I don't believe you can prevent the movement purely for the protection of some other state, because that same state has a right to protect itself and I believe it has to be given that privilege.

MR. BECKER: If a shipper comes up and says, "I want to ship this hay out of this infested area into some other state," he is offering that distinctly as an interstate shipment and not as an intrastate shipment. The state has absolutely nothing to do with that shipment. The state can step in and go this far: The state can say, "This interstate shipment jeopardizes the welfare of this state," and can demand treatment of those products in such a way, or it can demand the transportation of

those products in the way it deems necessary to protect the state, but other than that, it can not stop the shipment to some other state. If that hay were going across the State of Missouri into another state and Haseman's state would be in jeopardy, he couldn't stop it.

I believe Mississippi has some such regulation, or did have, with reference to the pink boll worm, but I believe they will find out that they can not interfere with an interstate shipment, one that goes across their state into another. They can say that that car of stuff can not remain there for more than so many hours or that it has to be fumigated or boxed up in such a way and manner, but when it comes to interfering with an interstate shipment, they can't do it.

MR. WALLACE: I think this thing came up when we had the meeting at Washington. If it goes on this way, I will have to be better posted on forty-seven other state laws than I am on those in Indiana. I ought to know Indiana better than the rest of you men, and if it goes on, I am going to have nothing to do with shipments in Indiana, but I will have to keep posted on forty-seven other states. I can't tell where that alfalfa weevil is in other states, and I think the regulations of those states ought to apply to prevent it's spread. Inspectors of other states should protect Indiana, and if we get anything in Indiana, leave it up to me to keep it at home. I think if you took it down to the federal court you would find you are wrong. I think I can stop a shipment in Indiana; I am willing to burn some of them and try it; we always have been able to do it and I think if that shipment of alfalfa hay came into Indiana and I had those regulations, I would burn it before I would let it go over into Kansas and then be trucked back.

Your assistant solicitor down at Washington I think brought that out. He said if you could take anything into the court and show that the federal rulings did not fully (and he said that word "fully" took in a whole lot of territory) cover the subject, your state regulations would hold. I think we ought to have some of the railroad representatives here. The railroads now can not keep track of all these quarantines. They have a horrible mass of detail for all the agents now and if it goes on with the recommendations that I hear this morning, why a 55,000 page book won't take care of them.

MR. HINDS: There is a little matter of cooperation which ought to be expressed here. When the inspector at the point of origin finds that an interstate shipment is purposed, I think he ought to at least advise the inspector at the point of destination that dangerous material is coming his way, and then if he wants to, he can take action and keep it out. It wouldn't be an illegal question at all.

MR. CORKINS: May I make Wyoming's position in this matter clear? As soon as this survey was made, the information was sent to the Pest Survey so that every entomologist in the country knew immediately of this new infestation. In addition to that, we sent personal letters to the entomologists where most of our hay is shipped, advising them of this new situation and asking them if they would impose a quarantine against our newly infested territory. We immediately placed on an intrastate quarantine covering our newly infested territory, and so far as our cooperation inside the Western Plant Quarantine Board is concerned, that constitutes our duty to our fellow state.

MR. WALLACE: May I ask, would you permit a car of that hay to be shipped out of that area now?

MR. CORKINS: I don't see how I could stop it. If you have no quarantine against it, I see no way to stop it. We have counties which join other states; how could we say to a county which is quarantined and joins another state that they can not ship alfalfa across the state line?

MR. WALLACE: What it will mean, when Indiana puts a quarantine on, it is against the whole state of Wyoming, and that will stick. Now I don't want to put a quarantine on; I haven't got any quarantines at all, but when one goes on, it is going to stick, and I think that is what it all ought to mean. If your law won't cover it, you ought to get a law that will cover it, because they can be written.

MR. FRACKER: I understood Mr. Dean to tell me that the State of Idaho is undertaking to prevent shipment of alfalfa from the infested districts of Idaho to other states. I should like to have Mr. Dean confirm that, if my impression is correct.

MR. DEAN: I just want to drop a word of advice or a suggestion right here: When any of you promulgate your quarantine, you serve notice on your transportation companies that they shall not accept a shipment of that product until that shipment is accompanied by a certificate of inspection. That is the case in Idaho. The railroads in the State of Idaho will not accept for a moment a shipment of those products until it is accompanied by a certificate from our department.

Our friend from Louisiana and Brother Haseman here have struck the key-note of the whole situation, and that is cooperation. We have found out in our activities in our Western Plant Quarantine Board on the Pacific Coast, that the only way for us to get at this proposition from a fundamental standpoint and obtain the best protection for each other is in closer understanding and a closer cooperation,

one state with another, and a closer cooperation within your state boundaries, county by county.

We have counties in the State of Idaho, in fact, all of the states that are infested with alfalfa weevil today, and we are just as jealous of their condition, as we are of any outside state, and at the same time I do not hesitate to say that we are jealous of our reputation to the effect that when we put our certificate on a shipment to go out of our state, we believe we are certain, so far as we can avail ourselves of that information, that that shipment is clean and healthful. When we have that confidence man to man, state to state, it will be a better protection to each one of us from the standpoint of the prevention of the introduction of any new pest or the spread of those we already have.

MR. STRONG: What do you certify, merely as to the locality of origin?

MR. DEAN: (Idaho): The condition of the territory from which it is shipped. We will not give a certificate on shipments of alfalfa hay out of that territory which we know to be infested. In that case over in Washington, there were two carloads that went out; one went in violation of our state regulation. There was no grade on the hay at that time, but it was sent out by a certain process of movement. The other carload from Elmore County carried one of our state certificates and they didn't find any alfalfa weevil in it.

MR. CORKINS: There seems to be a considerable difference of opinion with reference to this point as to whether or not we can protect the other states. May I suggest that possibly this body might appoint a committee to investigate this situation and report back next year.

DR. BALL: While the delegate from Wyoming states that he has the alfalfa weevil on the border of his state, the fact remains that you can't get a carload of alfalfa out of Wyoming without shipping it on a railroad that goes through an uninfested territory, so you can control it if you want to. If you want to control the alfalfa weevil in the State of Wyoming, you can do it; you don't have to invoke any quarantine from any other state. Your railroads are such that you have it absolutely tied up.

MR. HASEMAN: I would like to say that where we have federal quarantines enforced, there is relatively little difficulty, but in the case of the alfalfa weevil there has been no definite federal regulation enforced. Now if we can't get this cooperation and can't get the type of protection we would like to have, I see no other way out of it in our case. Kansas City is the distributing point for practically all of the South. The only remedy that I can see is to absolutely require that the shipment,

when it comes across the Missouri border for delivery in Missouri or reconsignment, must have a permit tag on it. I would rather not take that action, if we can get around it, but we are indirectly responsible for the spread throughout the South because we are the distributing point of alfalfa hay for that part of the United States, and if these shipments continue to come across from Kansas, we will have to slap a quarantine on Kansas or else resort to this permit plan.

MR. FARLEY: I think the gentleman is absolutely right. I sent the Missouri people notice of what was being done, as I thought that a violation of their quarantine should not be tolerated. I regret it very much, but I didn't see what else I could tell the railroad company, as we had no quarantine against Churchill County, Wyo. and I had no way to prevent them from unloading it in Kansas.

MR. MARLATT: I wish to state that the Department of Agriculture has a number of solicitors who have been giving a good bit of study to this general subject of power, state and federal, and if any of these questions come up which we can not settle, you will get the benefit of that information. Of course it won't be a court decision. Personally I think a state has more power of protection than some of you seem to think. I think they have power to protect against anything that moves through the state. The idea seems to be they have no such power. I think they do have. The state has a right to protect itself not only from things that come into the state but things that move through the state. They have to prove their case.

We can give a lot of discussion to federal-state powers and perhaps be wide of the mark, but on any of these questions which haven't been settled, if you want to get the opinion of our people I know they would be very glad to give it.

That conference which we held in Washington some year and a half or two years ago was very informing to most of us, and the analysis of decisions bearing on interstate movement, and state and federal powers, was distributed pretty widely at that time, but I think if any of you haven't got that analysis, we will be very glad to supply it. I think there is no question about the authority of the state to prevent any movement out of the quarantined area for the protection of another part of the state, and incidentally, that would affect the whole United States, but where the state quarantine line and the state line coincide on one side, for example, whether the state could prohibit the movement across that invisible line, I should want to put that up to the solicitor.

I would be very glad to have a decision made and submit it to the officers of this body for promulgation.

MR. G. M. LIST (Colorado): We had a quarantine in our state. We fortunately had the infestation at such a point in the state that any shipment would have to go through free territory, and we have depended mostly on that fact as a reason for placing this quarantine, but we also made the quarantine read that it would be a misdemeanor for a railroad or any transportation company to accept alfalfa hay, for instance, for shipment. Our attorney general told us that he was willing to back us up on that stand, and even though the weevil infestation might reach to our state line, we are planning to continue that policy and try it out, and under that plan we believe the other states are being protected as well as the rest of our own state.

CHAIRMAN CORY: Before taking a recess for lunch I should like to appoint S. B. Fracker chairman of the Committee on Resolutions, with Dr. Drake and Professor Bentley as associates. . . The meeting adjourned at twelve-twenty o'clock.

Tuesday Afternoon, December 29, 1925

The meeting was called to order at two o'clock by Chairman Cory.

CHAIRMAN CORY: We are fortunate in having with us this afternoon some of our co-workers in regulatory affairs, the pathologists, and Mr. McCubbin will give us the first paper in a symposium on Certain Plant Diseases as Related to Inspection and Quarantine.

THE WHITE PINE BLISTER RUST SITUATION

By W. A. MCCUBBIN, *Harrisburg, Pa.*

ABSTRACT

Features of the disease which have a bearing on control are outlined. The problem of pine protection by Ribes eradication is regarded as essentially solved; the country as a whole is protected by Federal quarantine; but there are still unsettled features connected with interstate quarantines and with nursery inspection methods.

A technical description of the white pine blister rust does not fit in with the aim and purpose of this program; but in order to provide an adequate basis for discussion it does seem necessary to review briefly several points in connection with this disease which have a definite bearing on the problem of control.

(1) Blister Rust is not of native origin, but was introduced from Europe in Seedling pines about 1906.

(2) It became established over large areas of the United States and

Canada either by direct plantings of these seedlings or by replantings of this same stock from nurseries.

(3) It is distinctively a disease of young pine trees; while it can kill and is killing older trees, it has shown particular virulence in trees of nursery age or young pine stands.

(4) It has for alternate hosts the various species of *Ribes* including wild and cultivated currants and gooseberries.

(5) Damage to Ribes is economically unimportant except in the case of the cultivated black currant which is severely attacked and which therefore stands out as the most important species of the alternate host group.

(6) Pine infection takes place only from Ribes so far as known.

(7) A long period may elapse between actual infection of a pine and the appearance of definitely distinguishable symptoms.

(8) The blister rust is perennial in the pine; pines are thus an efficient reservoir of infection.

(9) The uredinial stage on Ribes leaves spreads from plant to plant during the summer but it is thought that the effective range of spread in this way is not great compared with the spread from pines.

(10) Although wintering of the rust on Ribes has been established there is little evidence that such wintering is common in nature.

(11) The aeciospores may be carried long distances from pine to Ribes, hence this spore stage is of the greatest importance in long-distance spread. The summer spread by urediniospores from Ribes to Ribes covers only a relatively short range, but this stage is dangerous because of the multiplication that is brought about on the Ribes hosts. The spore stage which returns the rust to its pine host is very sensitive to weather and is short-lived, so that pine infection is likely to be irregular and to take place, for the most part, over very short distances.

(12) Practical commercial control is obtainable by the eradication of the *Ribes* hosts from and around the pines to a distance which will vary with conditions from 300 yards to a couple of miles.

Of the twelve features just outlined there are four points which stand out in bold relief: The possibility of long distance spread by wind-borne spores from diseased pines; the possibility of spread by invisible infections on nursery pines and perhaps also on Ribes; the weak, uncertain and restricted activity of the Ribes-to-pine stage; and the encouraging success of eradication methods based on this weak point in the life-history of the rust fungus.

Passing from this review of essential factors in the disease to a con-

sideration of the general blister rust program, one finds that discussion would fall naturally under four heads: the protection of pine stands and plantings by Ribes eradication; the national quarantine to prevent further introduction of the disease from abroad; interstate or regional quarantines; and blister rust and nursery inspection. Of these four the first has no need of further consideration here. The well directed efforts of the Federal Office of Blister Rust Control combined with the support provided by various states have shown such successful results that pine protection may now be regarded not as a problem but as a practice. Details of organization and methods are still subject to improvement, but the real problem of pine protection appears to be solved.

We may also dismiss without further mention the international phase of the blister rust problem since the Federal quarantine gives ample security on this point.

We are still confronted by certain difficulties in the matter of internal quarantines and nursery inspection. Generally speaking, the imposition of quarantines in blister rust has attempted to attain one of three objectives: permanent exclusion of the rust; delay in its spread; mitigation of the disease by reducing the amount of inoculum carried. In the Eastern states where both pine and Ribes hosts occur in a practically continuous belt through the whole of the white pine range, it was early recognized that the final invasion of the whole pine areas could scarcely be prevented. This view was strengthened when the wide dissemination of aeciospores mentioned above was fully brought out. Consequently, permanent exclusion of the disease from any portion of the eastern pine area is out of the question.

Up to 1920 no rust had been found in the Pacific Coast region and the hope was entertained that the prairie region would provide a permanent natural barrier to westward spread, so that protection of the western white pines could be attained if east-to-west movement of infectious material was effectually prevented. The finding of blister rust in British Columbia. Washington and very recently in Oregon ended all hope of completely isolating any portion of our continental white pine areas in a permanent way, and the best that any existing or future quarantine now can expect to attain is to delay the rate of spread or to lessen the amount of infection.

Since we are thus precluded from playing for the big stake of permanent isolation the situation in all the states has resolved itself into a gamble against time. And the action which each state will take, the effort it is willing to make, and the severity of its restrictions, must be

the outcome of its own necessities, governed by the extent of its pine industry, the local *Ribes* situation, climatic conditions, distance from the disease, probable damage, trade disturbance, and other similar factors. And since the values of these factors will vary considerably for each state or at least for the widely different regions in the vast areas exposed to blister rust, it is to be expected that each state or regional unit may wish to solve its problem in a manner peculiar to itself and not always in a manner satisfactory to its neighbors.

A state with few Ribes, and these easily eradicable, may regard the incursion of blister rust with complacence and act accordingly; a second state with much pine and infected Ribes puts most of its effort into an eradication program; a third state is full of pine but has no blister rust, and its chief thought is to keep that way; while a fourth state has so many Ribes in inaccessible locations that eradication is almost hopeless, and it looks over its pine in despair. These examples of possibly divergent interests and differing mental attitudes indicate that one of the most difficult problems confronting those interested in the blister rust disease is the working out of a harmoniously related system of interstate and regional quarantines.

From the outline of the disease presented at the outset it will be seen that long-distance spread takes place largely in two ways: by aeciospores carried in the wind; and by distribution of diseased pines or Ribes. We are told that "the wind bloweth where it listeth," and since there seems to be no feasible method of reducing, at its source, the inoculum thus carried, this method of spread appears to be beyond human control. With diseased pines and Ribes the case is different; it is obviously a matter of nursery inspection since practically all distribution of this kind would take place from nurseries. To prevent blister rust spread by nursery stock, various proposals have been made; the one extreme involves the prohibition of movement of all white pine and all Ribes from areas in which the disease is present; the other extreme is to permit shipment of this stock under ordinary nursery inspection and certificate. To place inspected nursery stock at the uncomplimentary extreme in this case may seem a trifle harsh, but to do so is no reflection on the nursery inspector. No doubt he could find all the well developed cases of blister rust in a nursery planting of young pines, but to locate all the incipient infections of a visible type requires such an exacting scrutiny of every twig and branch of these bushy, tufted plants that too great a percentage of infections will escape his eye. More important still is the fact that for a month to a year or more after infection the

symptoms of blister rust are so lacking or so indefinite that they defy recognition. It is perfectly possible for an inspector to pass a block of pines as visibly healthy and yet have every tree develop the disease in a year or two afterward.

Pine inspection alone is therefore utterly inadequate to prevent spread of blister rust, no matter how conscientious or careful the inspector may be. To overcome this defect in inspection methods it has been proposed to extend the inspection to include the Ribes in the nursery and its environs to such a distance as will guarantee freedom from infection. If a zone of suitable width surrounding a nursery shows no Ribes rust it is a fair presumption that the pines have not been infected. This method of pine inspection presents two weaknesses. The first being the added cost of inspection of the environs; the second involves the width of the zone. To keep the cost of inspection within reason the zone should not be too broad but it must be broad enough to give adequate assurance of non-infection. It is well to point out there that the recommendations given for Ribes eradication distances around plantings or natural stands are intended to provide commercial protection, which means merely that across the distance stated not enough trees will become diseased to affect the final stand. It is obviously unfair to apply these recommendations to nursery stock with the expectation of securing the total freedom from pine infection that is demanded of such stock if spread is to be prevented.

We are thus confronted by these alternatives: if the surrounding zone is restricted so that its inspection is reasonably possible, then the pines may be in danger; if the zone is so widened as to preclude danger of infection the cost of inspection is tremendously increased. In this connection it must not be overlooked that as yet we have no authoritative basis for setting the distance which will guarantee against all pine infection, though the distances worked out for commercial plantings provides a fair starting point for attempting to obtain data covering the practical conditions under which nursery stock is grown.

Although this problem of nursery inspection of pines is of comparatively little concern where pines are grown for planting in an infested area, and does not exist for nurseries in areas free from blister rust, it is of considerable importance where there is a possible movement of white pines from areas with rust to areas still free. Cases of this sort will no doubt continue to crop up until the disease has covered the remaining pine areas. For the present it may be said that these cases still await satisfactory solution.

The danger of blister rust spread through Ribes nursery stock rests largely on the ability of the fungus to pass the winter in or on the Ribes host. Clear proofs that the overwintering is possible are recorded but there is little evidence to show that overwintering of this type is of any general occurrence in nature. The rust has ample provision in the perennial pine infections to secure yearly perpetuation; the normal habit of the fungus on Ribes is to form the telial stage towards the end of summer which involves suppression of the urediniospores; and finally the total casting of leaves by Ribes in the autumn, are all points which would indicate that the normal procedure involves a complete dying out of the Ribes stages each autumn. If cases of overwintering occur they are probably accidental and consequently not likely to be numerous.

On the other hand the proofs of overwintering on Ribes are so final that nursery plants can not be disregarded as a means of spread, and this attitude is particularly important in regard to *Ribes nigrum*, the garden black currant which is subject to such heavy infection.

While the disease on black currants is so easy to detect that its presence or absence is readily established through ordinary summer nursery inspection, yet these plants have such low commercial value that in most cases the most practical method of dealing with this possible blister rust leakage is merely to plug the hole—in other words, stop their free movement entirely. The danger of spread from nurseries by other species of Ribes appears to be so slight that restriction of movement would seem to be justifiable only for special reasons.

MR. R. KENT BEATTIE: It may be of interest to know that the white pine blister rust has been found in Oregon this year for the first time. It was in British Columbia and Washington State, but this past season it has been found in the State of Oregon, and if my memory serves me correctly, it is within 125 miles of the sugar pine belt. The sugar pine, which is one of the very prominent timber trees in California, has its normal limits in the Cascade Mountains of Oregon, about opposite Eugene. This disease has its nearest point, as I remember it, on the coast, west of the Coast Range of mountains, about due west of Portland, and the disease must yet traverse a distance of about 125 miles.

There is also an infection in British Columbia, due north of the Idaho white pine belt and not very far from the international boundary. It probably will present a more immediate danger to the western white pine than this other one does to the sugar pine, for the ranges of

mountains runs north and south and the air currents will bring the spores directly south to the white pine in northern Idaho, and the only large belt of white pine left in the United States is in northern Idaho. The sugar pine is related, but it is a little different. I believe I am right in saying that the western white pine is more susceptible to the disease than the eastern white pine, as far as indications from present experiments show.

I also wish to call your attention to the fact that in the mountains of Idaho and Oregon and California there are many species of Ribes, where we have but say half a dozen here in the East. If my memory serves me correctly, there are sixty-nine species recorded for the three Pacific Coast states and Idaho. That immensely increases the problem. Also, remember that many of these Ribes are growing on inaccessible clifts in a mountain region where you can't possibly reach them, and secondly, west of the Cascade Mountains you have a dense underbrush, so dense that if you knew that on a certain acre tract there was a Ribes bush you would still have to work a long time before you could find it on account of the other underbrush, so that the problem is immensely more complicated there than in the East. They have been doing a great deal of work upon it. It is not going to be as simple a problem on the Pacific Coast as it was on the Atlantic.

Is there any further discussion?

CHAIRMAN CORY: We will proceed to take up "Crown Gall" by Mr. Melhus.

CROWN GALL OF APPLE NURSERY STOCK

By I. E. MELHUS, *Chairman Crown Gall Committee, Crop Protection Institute*

ABSTRACT

The work of Smith on *Bacterium tumefaciens* was followed by a period of generalization as to the prevalence of the crown gall disease.

Recent investigations have shown that a high percentage of the knots occurring on root-grafted apple trees are due to excess callus formation at the union of stock and scion. Apple stem tumors, and certain types of aerial galls on apple trees are thought to be an inherent varietal response. Certain types of hairy root on apple seedlings, previously supposed to be a manifestation of crown gall infection have been found to develop in the absence of *Bacterium tumefaciens*.

It has also been found in a majority of cases of galled trees, that there is a lack of continuity between the stock and scion. Such overgrowths produced by excess callus at the union of root-grafted trees have been shown to reduce materially the upward flow of water through the union.

When Smith and Townsend (14) in 1907 showed that *Bacterium tumefaciens* produced plant tumors, crown gall, known since biblical

times, passed from the realm of a disease of unknown origin. The subsequent studies of the senior author and his colleagues broadened during the next decade until it reached every aspect of the biology and pathogenicity of the organism. Smith (16) showed that it was "primarily a disease of the parenchyma" that induces the cells of the attacked parts to multiply, "the result being an imperfectly vascularized, covered or naked, irregular, soft or hard overgrowth, composed in part at least of masses of rapidly dividing, rounded or spindle-shaped cells of reduced size, forming a hyperplasia." He states further that "this disease is of a peculiar type: (1) in that the growth is extra-physiological, and injurious to the rest of the plant, slowly dwarfing or killing it; (2) in that secondary tumors occur as growths from tumor-strands which are bedded deep in the normal tissues and derived by growth, in the form of a continuous chain of cells, from the primary tumor; and, finally, (3) in that the secondary tumors reproduce the structure of the tissues, in which the primary tumor has developed, even when they appear in other organs." Smith has produced galls with *Bacterium tumefaciens* from the daisy and hop on more than 40 kinds of plants, belonging to 18 families.

Thus, Smith gave to the scientific world in a period of 15 years an array of facts regarding a bacterial plant pathogene, that truly were astounding. No other pathogene was known that would produce such a variable array of symptoms as secondary galls and various and diversified sarcomas and embryomas on roots, stems, and leaves.

It is common knowledge that many generalizations follow in the wake of all great discoveries. It was generalization that caused Fisher and other German pathologists to hold, that bacteria could not be the cause of diseases in plants. They argued that bacteria could only live in an alkaline medium at blood temperature, simply because all the pathogenic bacteria known at that time were animal parasites, and for them to exist in plants was impossible because plants are acid and low temperature organisms. As a result, Germany so advanced in her study of the fungi, yielded the leadership in bacterial diseases to America. The extensive generalization that followed the announcement of De Vriesian mutations are widely known. It required two decades for geneticists to become properly oriented. Much the same condition followed the rediscovery of mendelism; mendelian ratios for the next decade were used to explain all sorts of changes in genetics. At the present time we are carrying the influence of light on plant growth too far, and some time much work will be required to set its effects in their proper place with reference to other physical factors.

A quite comparable over-generalization from the fundamental work of Smith has occurred in the case of crown gall. For example, every form of overgrowth not definitely known to be due to other causes has been credited to the crown gall organism. Gradually, however, we have set our house in order and oriented the facts with reference to crown gall into their proper place and importance. Certain of the ground has been reworked, showing that Smith's discoveries were in the main, right, but in certain aspects, wrong. Other new discoveries have further clarified the problem.

Riker's (9, 10) discovery in 1923 materially simplified the problem of control, when he showed that the bacteria might migrate in the water-soaked inter-cellular spaces, and that they were carried for a considerable distance by the elongation of a rapidly growing stem. Secondary galls were, according to Riker, not the result of tumor strands developed from tumor-tissue by the sub-division of normal parenchyma, but the direct result of the migration of the bacteria and natural elongation of the stem. Two Englishmen, Robinson and Walkden (13), unaware of Riker's efforts advanced still more evidence, showing that the bacteria intrude along the inter-cellular spaces by zoogleal strands, and induce secondary galls only where inoculations are made in meristematic tissues near the apices of the growing stem. This new evidence, coming quite simultaneously from two different laboratories, means in practical terms that crown gall has little tendency to be general in its host. On the other hand it is quite local in its occurrence except where infection takes place in very young formative tissue, as bud tissue. This permitted us to say quite definitely that scion wood from infected trees is free from infection. A fact that had already been demonstrated in our (4) field trials, using scion wood from infected and healthy trees. Still further, it signifies that the presence of a gall on the root does not mean that the whole system is likely to be generally infected. The conception that *Bacterium tumefaciens* does exist generally some distance from the point of primary infection is unwarranted, and in many cases has led to destruction of trees otherwise desirable for planting stock.

Significant as the question of tumor strains or bacterial migration of the crown gall organism may be, it must yield first place to the recent researches, showing clearly, that many tumorous and hairy root formations are not due to a pathogenic organism. The first and very significant hint to this effect came from Miss Nellie Brown (1). She has recently showed that stem tumors of apple trees are not due to *Bacterium tumefaciens*. Heretofore all forms of stem tumors were grouped as an-

other diversified symptom of crown gall. She summarizes her work on apple stem tumors covering a period of no less than 17 years, by saying that outgrowths on stems of apple trees believed to be due to *Bacterium tumefaciens* "are not secondary outgrowths from tumor strands, nor are they primary infections of the crown gall organism." In describing these stem tumors, Miss Brown called attention, as is well known, to the fact that they are usually smooth, but in certain cases, "masses of aborted roots appear, giving a roughened bud-like surface to the outgrowth." It is quite probable that Miss Brown's stem tumors are the same thing as has long been known as burr-knots and which Swingle (17) has recently shown to be a varietal response. I have personally seen many such trees thrown on the brush pile supposedly as victims of crown gall.

More recently Riker and Keitt (11) have been studying the excrescences occurring underground at the union of piece-root-grafted apples. In a preliminary article they report that over 175 trees from seven nurseries in four states were examined, by making five attempts on each tree to isolate the causal organism without recovering *Bacterium tumefaciens*. They suggested that these excrescences were not induced by the crown gall organism, but that their development was merely incidental to the practice of piece-root-grafting, which confirms Hedgcock's experiments published in 1910.

In a paper now on press, they (12) have extended their studies to include 227 root-grafted trees from 12 different nurseries in six states, where they found the crown gall organism in less than two per cent of the trees.

In my own laboratory, from unpublished results, isolations made by Dr. Muncie and Mr. Patel, involving 282 isolations from 111 root-grafted trees, the crown gall organism has been recovered in only 7 cases. The overgrowths that yielded the crown gall organisms were of the soft gall type, except in two cases. Only one lot of trees to date has shown a high per cent of crown gall. This was a lot of 21 root-grafted trees, especially selected by Mr. Marshall and myself at Arlington, Nebraska. These trees were all taken from a small area of a field, said to have grown a crop of roses before it was set to apples. Isolations and inoculations into tomato showed, that 72 per cent of these picked trees yielded the crown gall organism. This case suggests that a lot of trees can be collected in which a high percentage of the overgrowths at the union are true crown gall, and that it can, to a considerable extent, be distinguished from other malformations. Furthermore, it shows how one might easily be deceived as to the real prevalence of crown gall by

studying only a comparatively few trees from an isolated locality. When we average all the isolations from the 338 trees made to date in two laboratories by two sets of different workers, we find that a low per cent of the trees studied yielded *Bacterium tumefaciens*. This cultural evidence is supported from still another angle:—namely, by the production of overgrowths, morphologically like those occurring on apple stock in the nursery on grafts made under aseptic conditions, and grown in steam sterilized soil in both the greenhouse and in the field. In other words, excrescences indistinguishable from those in the field may develop without the presence of *Bacterium tumefaciens*.

We come now to hairy root, another characteristic symptom of crown gall. That *Bacterium tumefaciens* will induce hairy root is easily demonstrated, but, as in the case of galls, we are finding that not all hairy root is due to the crown gall organism. Swingle (17) has found that burr-knots, already referred to are very potent sources for root development, and suggests that in the past such roots have been confused with hairy root. Muncie (8) has recently found at least two distinct types of hairy root on the underground parts of French apple seedlings. These types are (1) the woolly-knot form, arising from a distinct gall; and (2) the type in which fine fibrous roots arise in clusters from the tap root. The woolly-knot form has been shown to be infectious. The other type is probably not pathogenic. The latter is the most common on commercial apple seedlings as they occur in the field here in the middlewest. Few of the woolly-knot type are ever made up into grafts. They are sorted out in the field, and in the grafting room so that the chances for their being used is very limited.

Realizing that our studies had been made in a limited section of the United States, and knowing the wide variation in environmental influences and the diversification of prevailing nursery practices, a survey was made in cooperation with the Office of the Plant Disease Survey of the U. S. Department of Agriculture of the Eastern and Southern nursery growing districts. It revealed the fact that knot was much less prevalent on budded than grafted stock, and that true crown gall was general, but no more prevalent than in the middlewest. Hairy root of the several types mentioned was general and prevalent wherever apple trees were grown. The knots on grafted stock were also the same as to type, texture, and general location, indicating that the cause was probably the same.

At this point you naturally ask how these data relate to Erwin F. Smith's (15) findings. Smith in his isolation work on apple used, as far

as I am able to determine from his published records, 27 trees, nine of which showed hairy root and 18 galls. He recovered the organism from 8 of the 18 trees with galls and states specifically that 14 of the 18 trees had hard and two had soft galls. Only four of the 14 hard galls yielded the crown gall organism, while both of the soft galls gave up the pathogene. In the case of the nine trees with fleshy hairy root, he found the organism in six cases. That we have in the past confused excess callus called hard gall, with true crown gall; and non-pathogenic hairy root with pathogenic hairy root cannot be doubted.

We have generalized holding that, since *Bacterium tumefaciens* may produce galls and hairy root, all overgrowths and hairy root must be due to this pathogen. We ignored the well-known fact that similar symptoms may be induced by different causes. The evidence that I have presented shows clearly in my opinion that *Bacterium tumefaciens* is only one of the agents that induces these symptoms on the apple and we think, the one of lesser importance. Most of the so-called overgrowths and hairy root are due not to the crown gall orgnaism, but to inherent tendency of the variety, and faulty cultural practices, coupled with conducive environmental conditions.

You ask, what does this mean? Does it mean that we have solved the crown gall problem? Unfortunately we have not! We have merely shifted the load from one shoulder to the other. The problem still remains as pertinent to the nurserymen, orchardist and the layman as ever before. These trees bearing excrescences are still objectionable, and inferior for orchard planting. I know that there are those who hold that these malformations are not significant, and do not interfere with the tree's normal development. I know too, that in certain specific cases their contentions are true. I have seen in my own experiments (3) trees carrying overgrowths at the union develop quite normally, when set in the orchard. On the other hand there is even more experimental data showing that such trees have not lived and responded normally. It is perfectly natural that such conflicting conclusions should exist, considering the variation in stocks, the diversified causation and wide range of environmental factors in the different parts of the United States.

Why most trees bearing knots, and why certain trees with overgrowths have developed into normal trees has been quite fully answered in our experiments on water flow interference in relation to the degree of continuity at the union in normal and galled trees. It has already been shown (5) that in 100 trees of mixed varieties, an overgrowth at the

union reduced the rate of upward water flow 30 per cent. The interference or reduction in flow in three varieties is specifically stated by Muncie (7) in galled Wealthy, Salone, and Jonathan as 69, 21 and 42 per cent respectively. In other words a knot on the union reduced the rate of water flow from 21 to 69 per cent in different varieties. The greatest reduction occurred on the variety most susceptible to knotting in the nursery. Surely a tree that can function in its capacity to conduct water, only partially as well as a normal tree is not a safe investment for an orchardist. But let us look deeper into this difference in water flow. What caused this reduction in water flow capacity? Sections cut longitudinally through the union have revealed the cause. In 63 per cent of the knotted trees, the union of stock and scion was plainly imperfect. There was only partial continuity of tissues between the two primary elements of the tree. The lack of healing of the union or continuity of the stock and scion in over 50 per cent of the cases was on the scion lip side, and 10 per cent on the stock lip side. In the other 37 per cent of the knotted trees it was not so readily possible to explain the reduced flow. It is conceivable that there may be still other causes for such response, that we do not as yet recognize. These findings are in accord with Hedgecock's (2) experiments in which he showed that in 90 per cent of the galled trees the excrescence was at the lower end of the scion where callus tissue formed abundantly under favorable conditions.

Nevertheless, we do know that the water flow capacity in the majority of knotted trees is due to the lack of complete continuity at the union, and it seems that the formation of a knot at the union is an attempt on the part of the tree to make this contact. The tissues laid down at this point result from the downward flow of food materials on that side of the tree, where continuity does not exist. A knot at the union on two year old piece-root-grafted trees, therefore, is a sign of a partial break in the continuity at the point of contact between the elements of the tree, which reduces its water conducting capacity. That such trees do not develop as rapidly as normal trees for the first four years that they stand in the orchard has been demonstrated in our orchard experiments (3). That they may outgrow this defect can only be proven by extensive long time orchard experiments, which are frequently complicated by the many surrounding variable factors, and are therefore seldom fully convincing.

The outcome of such orchard trials need give us little concern, because the orchardist does not want galled or knotted trees from the nurserymen, and it is equally true, that no conscientious nurseryman

wishes to sell them, when other normal trees are available. Therefore, the inspection service whose function it is to protect the consumer has no new obligation, nor are any of their responsibilities removed.

The real responsibility rests with us to show the nurserymen how to produce stock free from knots and free from crown gall and hairy root. They want this information, and the past two years have demonstrated thoroughly that they are willing to pay for it, even though there may be some question as to whether such a responsibility is justly incumbent upon them. It is not a question with them whether a galled or knotted tree is or is not as good as a normal one. Every conscientious nurseryman wants to deliver to his trade unblemished trees. Even with this sympathetic response in money and materials from the nurserymen, the remaining task is not an easy one. There are many difficult questions involved that cannot be answered quickly. I need only remind you of the fact, that it takes at least two and in some sections three years to grow an apple tree, ready to be set in the orchard. Still further, a well established nursery practice is not easily altered.

There is an endless chain of specialized nursery and cultural practices applied to the tree in its making and growth in the nursery. Any modification in practice very easily disturbs the balance, baffles the grower, and increases the overhead. It might be suggested that we recommend budding instead of grafting, a more expensive practice that has prevailed for a long time in some sections. We already know that budded trees are not as subject to knotting as piece-root-grafted stock. But this raises a much mooted question in horticulture, the comparative value of budded and grafted stock. Many orchardists refuse absolutely to plant budded trees. They insist on piece-root-grafted stock, and the contention to my mind is well founded for some sections of our country.

In the process of grafting itself there are many problems, that present themselves for solution, which bear directly on inducing a perfect connection at the union. It involves more than telling the nurseryman to take more care in the process of making his grafts, such as securing a better fit and tying down the scion lip. Such simple precautions have occurred to the nurserymen many times, and been tried with painstaking care by many, some with success, others with none, indicating clearly that other factors are involved. We are confronted with the condition in the stock and scion wood previous to making of the graft, known as seasoning, the influence of environmental conditions on the growth and callousing, while the graft is stored previous to planting,

and the congeniality of different varieties of scions with the seedling stock, each of which is genetically unlike every other seedling.

Then we have another set of markedly different influences operative in the graft when it is set in the field; the role of *Bacterium tumefaciens*, and lastly the activity of insect pests, such as the woolly aphis and in some southern sections the eel worm must not be overlooked. Much remains to be done on the relation of the crown gall organism to properly orient it with reference to the nursery and orchard industry. The significance of the woolly aphis pest demands very serious consideration, and it is to be hoped that Entomologists will renew their interest in this problem, and contribute to its rapid solution, coordinating their work with other specialists.

To assemble the answer to these questions, and modify nursery and cultural practice so as to prevent crown gall infection, and the formation of knot and non-pathogenic hairy root developments is indeed a complicated problem, that will require the coordinated effort of specialists working in their respective fields in close cooperation with the nurserymen. In other words, the problem is not solved, and there is much that remains to be done, but we have arrived at a stage in our investigation, when we can begin to hope for some relief. By relief, I mean that time, when the tremendous waste, that now takes place in the nursery and orchard may be saved through the greatest utilization of our efforts. I am led to raise our hopes to this extent, because we have now lived through the period of over-generalization referred to earlier, and we have had time to lay a solid foundation, and to set our house in order, so that we may, now, point our efforts toward control.

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MR. GLENN: We don't like to throw aside a good sized healthy tree because it has crown gall.

MR. MELHUS: In the light of what we know now we would not throw it aside.

CHAIRMAN CORY: We will pass to the next paper in the symposium, "Virus Diseases of Raspberry," by Mr. R. B. Wilcox.

VIRUS DISEASES OF RASPBERRY

By R. B. WILCOX

(Not submitted for publication)

CHAIRMAN CORY: Discussion will be deferred until we have heard a paper by A. G. Ruggles and J. D. Winter.

THE CONTROL OF MOSAIC OF RED RASPBERRIES FROM THE NURSERY INSPECTOR'S STANDPOINT

By A. G. RUGGLES and J. D. WINTER

ABSTRACT

Commercial plantings of red raspberries in Minnesota were found to contain a large amount of mosaic infection according to a survey commenced in 1923 and completed in 1924. An attempt to control this disease in the propagating stocks of red raspberries throughout the state was begun in July 1924. Very satisfactory results have been obtained indicating control by roguing is practicable provided that infected raspberries from which mosaic may be transmitted are not within

twenty rods of the rogued planting. Plants of the Latham variety taken from 18 isolated plantings rogued in 1924 averaged only 1.3 per cent mosaic in 1925 out of 112,110 plants in 34 separate plantings. Plants of the Latham variety taken from 14 non-isolated plantings rogued in 1924 averaged 9.0 per cent mosaic out of 53,990 plants in 33 separate plantings. Approximately 125 acres of red raspberries were rogued for the control of mosaic disease in propagating stocks during 1925.

Minnesota raspberry growers, in common with growers in other sections, have found that varieties of raspberries after being grown continuously for a number of years gradually deteriorate and finally "run out." In Minnesota the growing of several popular and once profitable varieties has been practically abandoned. The possibility that this condition might be due to mosaic or other systemic diseases was first brought to the attention of the office of Minnesota Nursery Inspection in the summer of 1923. A preliminary survey was made at that time with a view to determining the status of mosaic in Minnesota raspberry plantings. It was found that symptoms were present in many plantings which were not characteristic of normal growth. We were not convinced until 1924 that this was a diseased condition.

During the season of 1924 a careful survey was completed. This survey indicated a high percentage of mosaic in the two varieties of red raspberries commonly grown for commercial purposes namely the Latham and the King. A total of 105 commercial plantings of Latham were carefully examined and found to range from ½% mosaic to 100% mosaic, averaging 73% mosaic for the entire group. The King plantings were found to average 35% mosaic for the 25 plantings which were examined for this purpose. Further observations indicated that similar conditions prevailed wherever red raspberries were grown in the state. Leaf curl and other systemic diseases were found to be negligible in these and other red varieties. Several less important varieties of red raspberries were found to be relatively free from mosaic.

As the Latham variety is a Minnesota production and as both Latham and King are our most valued varieties for commercial use, an attempt was immediately made to secure healthy stock for propagation. An extensive program to control mosaic by roguing was adopted. Thirty-three plantings of Latham and nine plantings of King were rogued during 1924 in addition to plantings of a number of other varieties. Definite action was not decided upon until July 3rd, 1924, so that the first roguing did not take place until after that date. Each planting was rogued twice.

In 1925 these plantings and their progeny were closely studied. Uniform methods were employed in computing the percentage of mosaic

present in each planting. The following conclusions were reached as a result of these studies and are supported by the data obtained:

1. That mosaic can be effectively controlled by roguing.
2. That isolation from nearby sources of infection is essential in control.
3. That detection of the very early stages of mosaic is necessary to control.
4. That mosaic as diagnosed under standards of inspection in Minnesota is definitely systemic.

All evidence presented in support of these conclusions is confined to the Latham variety although similar results were obtained with other varieties. The Latham, including the so-called Redpath strain, is found to be as susceptible to mosaic as any other variety observed.

1. That Mosaic can be Effectively Controlled by Roguing

The average amount of mosaic rogued in 1924 from the 33 certified Latham plantings was 6.6%. During 1925 it was found that plants from only one of these 33 plantings contained too high a percentage of mosaic to make roguing practicable. The fact that no plantings were refused certification in 1924 on account of proximity to nearby infected plantings accounts for much of the infection averaging only 3.8% found in the progeny which was inspected the following season.

It was soon apparent that effective control of mosaic could not be secured unless the rogued planting was properly isolated from nearby infected raspberries. The results obtained in mosaic control are so closely associated with the factor of isolation that further evidence of successful control will be presented under the following section devoted to isolation requirements.

2. That Isolation from Nearby Sources of Infection is Essential in Control

Table No. 1. Plantings Established in 1925

	Total plants inspected	No. of plantings	Total plants rogued 1925	Percent mosaic
Progeny from 18 isolated plantings	112,110	34	1,465	1.3%
[1]Progeny from 14 non-isolated plantings	53,990	33	4,851	9.0%
Progeny from 32 rogued plantings	166,100	67	6,316	3.8%

[1]All plantings isolated less than 20 rods are included.

During July, August and September of 1925 a total of 166,100 plants taken from 32 plantings certified in 1924 were carefully examined. Each

plant was inspected individually and mechanical counters were used to obtain the correct count. A total of 67 individual plantings were included of which 34 were inspected twice during that period. The progeny from 18 isolated plantings, representing the plantings which would be certified under present Minnesota regulations, averaged only 1.3% mosaic. The progeny from 14 plantings not properly isolated, which were certified in 1924 but would not be certified under present regulations, averaged 9.0% These figures show very plainly the influence of isolation.

TABLE NO. 2. PLANTINGS ESTABLISHED PRIOR TO 1924

	Number certified		Not passed	Av. % mosaic		Discontinued
	1924	1925	1925	1924	1925	1925
Isolated plantings	19	14	2[1]	6.0%	3.8%	3
Plantings not isolated	14	3	10	7.5%	18.1%	1

[1]The two isolated plantings not passed in 1925 were refused certification on account of failure to carry out roguing instructions. They are not included in the percentage given, namely 3.8%.

A distance of 20 rods isolation was recommended by the office of Nursery Inspection on July 3, 1924. During the season of 1925 isolation of 5 rods was required in order to consider certification, so that a number of plantings certified in 1924 did not pass inspection in 1925. The isolated plantings averaged 6% mosaic in 1924 which was reduced to an average of 3.8% in 1925. The plantings that were not isolated averaged 7.5% mosaic in 1924 and 18.1% mosaic in 1925 including three plantings which were sufficiently isolated to pass the 1925 inspection. In these older plantings, as the data show, the amount of mosaic in the isolated plantings was held well in check. In the non-isolated plantings for the most part little or no control was obtained.

Evidence obtained in 1925 indicates that 5 rods isolation is not sufficient under Minnesota conditions and the full distance of 20 rods as first recommended in 1924 will hereafter be considered necessary if plants are to be grown for sale. An instance of apparent spread for a distance of 8 rods will be cited in support of the foregoing conclusion. A certain 3 and 4 year old planting was inspected twice in 1924 and a total of 3% infected plants rogued out. This planting of about three-quarters of an acre was situated 120 feet east from a badly infected planting which had been planted at that distance in the spring of 1923. The rogued planting was inspected again on May 26, 1925, at which time 3% mosaic was found and rogued. On June 17 a second inspection was made and 5% mosaic rogued. A third inspection was made in August and the planting rejected. At this last inspection the three

west rows were found to contain 31.3% mosaic while the balance of the planting comprising 21 rows contained approximately 1% mosaic.

TABLE No, 3. PLANTINGS ESTABLISHED IN 1925

	Total plants inspected	No. of plantings	Total plants rogued 1925	Per cent mosaic
Selected progeny from 21 unrogued plantings	31,630	23	4,865	15.4%

A number of growers selected apparently healthy plants from some of the best unrogued plantings and attempted to establish healthy plantings with this stock in the spring of 1925. A total of 31,630 such plants were inspected in 1925 and were found to average 15.4% mosaic. In general this practice was not successful. The results indicate the necessity of securing plants from isolated plantings.

3. That Detection of the Very Early Stages of Mosaic is Necessary for Control

The fact that encouraging results are being obtained indicates that more or less correct standards of diagnosis are being employed. The presence of mildew and red spider frequently covers up or masks symptoms of mosaic to such an extent that much confusion may result if inspection is casually done by one not accustomed to this type of inspection.

During the season of 1925 many plants whose symptoms might be considered doubtful were staked and watched. This refers to slight symptoms of abnormal systemic conditions without the usual specific symptoms of mosaic being discernable. Almost invariably typical mosaic symptoms appeared within two to six weeks. As a result of these observations all plants which were formerly considered as doubtful are now diagnosed as being infected and are rogued.

4. That Mosaic as Diagnosed Under Standard of Inspection in Minnesota is Definitely Systemic.

TABLE 4

Parent planting	No. of progeny plantings	Total plants inspected	Max. % mosaic	Min. % mosaic	Av. % mosaic	Av. deviation from the mean
A	4	53,400	1.0%	0.7%	0.8%	0.1%
B	13	15,265	19.0%	10.1%	13.7%	2.6%
C	5	9,600	1.8%	0.4%	0.9%	0.4%
D	7	14,206	2.6%	0.0%	0.6%	0.7%
	29	92,471				1.4%

During 1925 the progeny from four plantings was carefully checked to determine the uniformity of symptoms appearing in different plant-

ings established from the same parent planting. A remarkable degree of uniformity was found in spite of the fact that many of the progeny plantings were established in widely separated localities. The maximum deviation from the average percent of mosaic in a total of 29 progeny plantings was only 5.3% and the average deviation 1.4%.

Summary

From all of these data it appears obvious that control of mosaic by roguing is practicable, provided that infected raspberries from which the disease may be transmitted are not too close at hand. Approximately one hundred and twenty-five acres of red raspberries were involved in the roguing work carried on, for which two inspectors were available most of the time. The careful attention given each planting was no doubt an important factor in the control obtained.

General Conclusions

As a result of the roguing work carried on in 1924 and 1925 the following conclusions applicable to Minnesota conditions have been reached:—

1. Mosaic of red raspberries can be effectively controlled by roguing.
2. Plantings must be isolated not less than 20 rods from infected raspberries for the production of healthy plants. For fruit production a shorter distance may be sufficient.
3. Plants should be secured if possible from a planting which has been rogued for not less than two successive years.
4. At least two roguings not less than 30 days apart are necessary each year, the first between June 1st and July 15th and the second between July 15th and September 15th.
5. If more than 5% mosaic is found in a planting more than one year old roguing is usually not practicable; in a first year planting satisfactory control is possible where as much as 15% mosaic is found.
6. Roguing must be done carefully and thoroughly and all plants standing next in the row to infected plants must be rogued. During the first three to four months from planting it is possible that adjoining plants need not be rogued.

Chairman Cory: We will pass to the paper by Mr. E. C. Stakeman.

STEM RUSTS OF WHEAT AND OTHER CEREALS

By E. C. Stakeman, *Minnesota*

(Paper not submitted for publication)

CHAIRMAN CORY: The next paper on is by Mr. J. H. Newton.

STATUS OF THE ALFALFA WEEVIL IN COLORADO

By J. H. NEWTON, *Paonia, Colorado*

ABSTRACT

In 20 years the alfalfa weevil, *Phytonomus posticus*, has spread from an area near Salt Lake City, Utah, until it is now present in at least one or more counties of seven states, namely: Colorado, Wyoming, Utah, Idaho, Nevada, Oregon and California. During the past summer the insect was found on the east slope of the Continental Divide in the State of Wyoming. With the insect established on the east slope of the Rocky Mountains, there is considerable debate and difference of opinion as to the possibilities of the insect becoming a menace to the alfalfa production of the Missouri Valley states.

Colorado has maintained local quarantines on the movements of hays and straws as a means of retarding the spread of the insect. The weevil has been present in Colorado for eight years, during which time it has spread at the rate of six miles per year, but no long jumps have taken place. The problems presented by the tourist travel, immigrant travel, and other interstate relations are factors that must be further studied to retard the spread of the insect. It is essential that there be a uniformity of quarantines in order that the greatest protection may be secured at the least interruption of every day activities.

Natural control of the alfalfa weevil by the introduction of parasites from Europe is being pursued by the U. S. Bureau of Entomology, and we look forward to future introductions that may solve the control of the insect.

For the past 20 years entomologists and other agricultural workers in the western United States have watched with interest the spread of the alfalfa weevil, *Phytonomus posticus*, from the original introduction into America. During that time, the insect has spread over a length of radius varying from three to five hundred miles, until today it stands at the door of an area which produces approximately one-third of the alfalfa tonnage of the country. First experiences with the insect in America indicated that it might prove to be a very serious pest of the alfalfa plant, which is a basic part of western agriculture. It is the belief of the author that the possibilities of the pest in the western United States are not fully known.

Today the alfalfa weevil situation stands before the judicial gaze of all the western states. According to Cooks'[1] theory, only certain portions of states west of the Rocky Mountains need feel concerned about the future. The new infestation in eastern Wyoming certainly throws a new light on the situation. Although not heretofore expressed, it has been felt that eastern Colorado might become infested more readily from western Wyoming than through western Colorado, and now it is

[1]Journal Agr. Research, Vol. XXX, No. 5, 1925.

very probable that such will be the case. With the insect established on the eastern slope, it is beyond the author to attempt to predict the future for eastern Colorado. It is expected that the insect will find some portions of the country favorable for its propagation. The Arkansas Valley in the southeastern part of the state is looked upon as a very favorable breeding ground, once it becomes infested. Certainly we are not willing to let the insect have a free hand and will use every precaution to check its spread in Colorado.

Experiences with the alfalfa weevil in relation to regulatory work may be interpreted to prove most any point. It will be the intent of the author to present herewith a brief account of experiences with its dissemination in Colorado as met with in the quarantine and research work.

The first year (1918) of scout work outlined the infestation as occurring in the upper portion of the North Fork Valley of the Gunnison River, extending from three miles south of the town of Paonia to scattered fields 12 miles up the tributary valleys to an altitude of 7500 feet. Colorado established a local quarantine just as soon as the presence of the weevil became known. It was not expected that the local quarantine would materially check the natural spread of the insect, but it was hoped that it would lessen the danger of dissemination to distant areas and possibly retard, to some extent, the infesting of adjacent territory. The year 1919 found the weevil established on Payne's Mesa, 15 miles further west in Delta County, and a new infestation in Montrose County. It is believed that the Payne's Mesa infestation was of as old standing as the original outbreak at Paonia. From 1918 to 1923, the average rate of spread from Paonia has been six miles per year. The infestation at Montrose offers a more intimate study of the rate of spread from a small area that could be closely watched. From this area the spread has averaged two to three miles per year. It is understood that the average spread in the state of Utah has been approximately ten miles per year.

The problem of the tourist, the transient laborer during the harvest season, the movement of farm products, all represent just a part of the many artificial factors contributing to the dissemination of the pest. In Colorado it is beyond the funds and equipment to patrol each and every outlet. We have endeavored through educational channels to inform the public of the most dangerous means of spreading the insect. The infested counties have cooperated with the state office in furnishing local pest inspectors who take an active part in the operation of the

quarantine. It should be mentioned here that the local railroad officials are placed to considerable annoyance, and that their cooperation has aided materially in clearing interstate shipments.

It is understood that certain states have more active quarantines that give particular attention to the tourist and immigrant travel. It is granted that such inspection checks some introductions, but the question arises as to what assurance they have of the safety of the bedding, camp equipment, car, and even the clothing of the occupants themselves. Those cars that bear licenses from an infested territory are given most rigid inspection. What of the tourists that spend a few weeks in the harvest work in an infested area and than move on? They may be the most potential carriers but escape rigid inspection.

In observing the dissemination of the alfalfa weevil, some facts may be of interest here. Even though it has been demonstrated that irrigation waters carry the insect down stream, the most rapid spread has often been up stream. One particular case in mind is that of a number of fields which have not become infested even though they are continually irrigated from a ditch that flows through an infested area on a mesa, or table-land, above. In other cases, the insect has failed to spread to adjacent territory for more than one mile in three years where all conditions seem to warrant a rapid natural spread.

Just how the alfalfa weevil reached Colorado, and by what means it may reach the east slope, is a vague question. The most feasible solution of the Delta County infestation is that it may have been carried in by contractors from the State of Utah, who shipped in horses and hay during the construction of some of the irrigation laterals in the North Fork Valley.

The quarantines in force in Colorado prohibit only the movement of hays and straws. How much protection this may give cannot be fully interpreted. It is true that the topographical boundaries in western Colorado have limited the spread of the weevil since 1922. However, previous to that time, the spread was not as rapid as where no local quarantines were in effect. Before the occurrence of the weevil in Colorado, the pest had made no outstanding jump to new territories in America, but in recent years there have been isolated infestations in the states of Idaho, Oregon, Nevada, California and Wyoming. This would seem to indicate that the insect is capable of being carried long distances by artificial agencies. With eight years in Colorado, it has not made any great jump that we know of.

With the stimulated interest in the alfalfa weevil situation, it is

gratifying to note the efforts being made to unify the quarantines pertaining thereto. This is undoubtedly a direct result of the activity of the several Plant Quarantine Boards, and should be fostered. Uniformity in quarantines means an interstate cooperation that will insure the greatest protection with the least interruption. We should unite our efforts toward a thorough understanding of each other's problems with the assurance that each is doing his part to check the spread, and in the meantime, work out control that will be most economical.

Natural control of the weevil in Colorado has been stimulated primarily by the introduction of a larval parasite, *Bathyplectes curculionis*, which was made possible through the cooperation of G. I. Reeves, of the U. S. Bureau of Entomology. Since its introduction the parasite has multiplied rapidly until in some fields the parasitism is 80 per cent. It is believed that this parasitism is a substantial aid in control, and we look forward to future work by the U. S. Department of Agriculture along this line.

MR. GEO. ARNOLD: I should like to ask Mr. Newton what danger he thinks there is in transportation of alfalfa meal.

MR. NEWTON: We have a regulation whereby the meal can be ground and shipped under certain restrictions. There will have to be a stipulation as to the type of screen it would pass through, the care of the meal, how far they sack the material from the grinding point, and a good many other points. It would probably be necessary to have the sacking room a considerable distance from the grinding room.

MR. BECKER: I would like to hear some discussion as to what we might expect from the alfalfa weevil in the Mississippi Valley, for instance. The Federal Horticultural Board has made no effort in the matter of protecting the country as a whole against the spread of the alfalfa weevil and I think this is a matter for serious discussion.

MR. GEORGE I. REEVES: I wouldn't attempt to answer that question at all. There is no doubt that the alfalfa weevil is controlled very largely by climatic conditions. It would be foolhardy, I think, to make any predictions.

CHAIRMAN CORY: I would like to ask if dry weather is essential for the development of the pest, particularly whether it is essential for hibernation.

MR. GEORGE I. REEVES: So far as I know, it is not. I would say we have fairly definite ideas as to the effect of temperature upon the species, but if the matter of moisture is important, we don't know a

great deal about it. Of course the effect upon the crop is a result of two things—the activity of the insect and the activity of the plant. If we have a crop from the first cutting of alfalfa, it is because the plant outgrows the injury; if not, it is because the alfalfa weevil destroys the tissue faster than the plant can produce it, and there is no question that moisture has a great deal to do with the production of the crop. In that way it contributes to the general effect, but we have no very definite understanding of the effect of moisture upon the insect except in so far as it is influenced by the temperature. The oviposition of the alfalfa weevil is controlled pretty definitely by the temperature. For the purpose of planning control experiments on the alfalfa weevil, we are able to predict fairly early in the season whether we are going to have it in a locality or not. Occasionally we slip up, but in general it is fairly well established that the amount of alfalfa weevil damage depends on the temperature.

MR. HASEMAN: I should like to ask Mr. Newton how extensive his scouting work has been throughout the eastern part of Colorado in the last season or two.

MR. NEWTON: We have not started in eastern Colorado, because we haven't had knowledge of any infestation anywhere in the state on that side of the Continental Divide. Previous to this year we did not cross the Continental Divide. The Continental Divide would be harder to cross in Colorado than in Wyoming, if my knowledge of the area is correct.

MR. CORKINS: Bearing on this question, I wish to say that infestation in eastern Wyoming is new only in so far as we have just recently discovered it. Mr. Newton has brought out the rapidity of natural spread of the alfalfa weevil and I wish to call your attention to the fact that it occurs in this so-called newly infested territory, in a continuous strip of the alfalfa growing section something over 100 miles long with the eastern and western limits of this newly infested territory over 20 miles apart, and that the infestation is within less than 50 miles of the Nebraska line. There are two areas in this territory which show some slight damage this year. However, the growers themselves had never detected it and didn't know that anything was damaging their crop. These two areas where some damage occurred are isolated one from the other about seventy-five miles.

There is another particular condition that I want to call your attention to, and that is sort of an oasis in a desert region which is isolated twenty-five miles from any other alfalfa, and here also the alfalfa weevil

was found. This indicates that it had been present at least for several years. Just how many years it has been on this side of the Continental Divide, of course, we can only speculate, but I do wish to call your attention to the fact that it has been there for a number of years and yet has never done sufficient damage under these new environmental conditions to attract the attention of the growers.

MR. NEWTON: Mr. Chairman, the question arises in my mind as to the probability of the infestation in the eastern part of Wyoming having resulted from the spread of the insect from the original infestation in the western part of the state.

MR. REEVES: There has never been a continuous scouting trip from western to eastern Wyoming. The nearest was in 1919 or 1920. Mr. Chamberlain and I made periodical trips every year or every other year up through the western part of the state of Wyoming and defined the edges of the region, but we did not go across the mountains into the Mississippi Valley. There was an extension eastward along the southern border of the state. Then there is a great gap where there is no alfalfa, where it would be practically impossible to scout for weevil.

MR. NEWTON: I might say we are attempting to keep in touch with those areas adjacent to the infested areas.

MR. HASEMAN: I presume we can only speculate about what may happen if the alfalfa weevil comes on down into the Valley and eastward, but if we may judge by what the Mexican bean beetle has done, it seems to me that the situation may be a good deal more serious than I know some of the entomologists think it is likely to be from what I have heard.

CHAIRMAN CORY: We will pass to Dr. Haseman's paper.

MISSOURI PLANT ACT OF 1925

By LEONARD HASEMAN, *Columbia, Missouri*

In 1913 the Missouri Legislature repealed two previous attempts at Plant Pest Acts and passed an inspection law directed primarily at the horticultural pests and nursery inspection.

With the more recent threatening advance of the European corn borer, pink bollworm of cotton, Japanese beetle, alfalfa weevil and other scourges, the 1913 Act was found too limited in its scope. Last winter when the Legislature was in session the question of revising the old law or the presenting of a new bill was discussed and the latter was decided on. Under the old law the enforcement of the Act was a regular Agricultural Experiment Station project and the police phase of such

enforcement is logically not Experiment Station work. In the new bill therefore provision was made for a State Plant Board to administer it.

The new law is an almost exact copy of the so-called National Bill framed some years ago by a committee of Plant Quarantine officials cooperating with a committee of the American Association of nurserymen. The bill is broad and yet specific and when supplemented with a complete set of Plant Board rules it adequately covers all phases of protection to plants and plant parts.

The provisions of our law are embodied in the laws of a number of other states and while we have had but one year's experience with the new law it seems to cover Missouri's needs fully. It authorizes the Plant Board to make or amend rules as conditions necessitate and to establish intrastate quarantines as well as quarantines against outside areas and plant pests. This it seems should take care of future developments in the way of new plant pests and the protection of this state against them.

The State Plant Board as named in the law consists of the President of the State Board of Agriculture, the President of the State Horticultural Society and the Dean of the Agricultural College. The Board is, therefore composed of the heads of the three state institutions or organizations directing the progress of Missouri agriculture. The protection of the farmers, fruitgrowers, nurserymen, florists, gardeners and others from the future inroads of plant pests is fully looked after by his representative Board.

The executive officer of the Plant Board is its Chief Inspector and State Entomologist. The law designates the Entomologist of the Agricultural Experiment Station as this officer. At the present time the Board has two Deputy Inspectors. The Board is also cooperating with the Federal Department.

The state Plant Board has held two regular meetings and as authorized by the law has passed twenty-five rules and regulations. It has definitely named fourteen insect pests and diseases as public nuisances and thirty others of such nature that their dissemination should be prevented.

At the present time the Board has promulgated only three quarantines. One of these is directed at the pink bollworm, the second at the alfalfa weevil and the third at the European corn borer. A number of quarantines against other pests defined by the Board as public nuisances are being prepared for promulgation.

In all of its work to date the Board has insisted on, first, providing adequate protection to Missouri Agriculture against insect pests and

diseases and second, providing this with the least possible interference with commerce. No radical changes have been made as regard nursery inspection or the movement of nursery stock, but the taking of definite action in the way of enforcing quarantine regulations is a new departure of the Missouri Plant Pest Control Work.

Mr. Haseman took the chair while Mr. Cory presented the following paper.

DESIRABILITY OF FUMIGATING DORMANT NURSERY STOCK

By Ernest N. Cory, *State Entomologist*

Considerable divergence in the practice of fumigating deciduous nursery stock obtains in the United States, and there seems to be a divided opinion as to the general necessity for fumigating stock that enters commerce. In the past, the presence of the San Jose Scale as a distinct menace to horticulture was responsible for many of the laws and regulations now in force. However, successful methods of control have so reduced the menace of this pest that some states have discontinued general fumigation and only require their nurserymen to fumigate when it is necessary to meet the regulations of the state of destination.

The Maryland law requires inspection of nursery stock as a prerequisite to the movement from the nursery where infested material is found. Scale infestation has become a rarity in Maryland nurseries, owing probably to the practice of fumigating bud sticks and scions throughout the early years and the gradual elimination of the scale as a factor in orchards where propagating wood is being obtained for the nurseries. The writer feels that fumigation properly conducted, either of propagation wood or nursery trees, does not result in any serious injury. In fact, tests made by the writer gave more uniform stands from fumigated bud sticks than was obtained from unfumigated checks, budded by the same workmen under similar conditions.

The ineffectiveness of fumigation as a 100% guarantee against dissemination of live scale has been pointed out by a number of workers, and the attitude of nurserymen and growers towards possible injury from fumigation has been pointed out in a concise way by J. J. Davis. With a view to the divergence of opinion and practice with regard to the requirement of fumigation and the objections that have been raised to the procedure as to effectiveness and possible injury to the nursery

stock, the writer undertook to ascertain the attitude of mind of inspection officials on this subject, primarily with regard to the section embraced by the Plant Conference Board of the Middle Atlantic and Northeastern States. As there seemed to be no unanimity in regard to the practice of fumigation, it seemed desirable that this subject be brought before the Section of Plant Quarantine Inspection. In order to obtain an open discussion to determine, if possible, whether an agreement could be reached on the desirability or non-desirability of fumigation as a prerequisite to shipment, either interstate or intrastate, a questionnaire was sent out to inspection officials throughout this country and Canada. Forty replies have been received from the states and one from Canada. The answers are summarized herewith as follows:

Number of states requiring fumigation for interstate shipments	10
Number of states requiring fumigation for intrastate shipments	9
Number considering fumigation generally desirable	19
Number requiring fumigation under special circumstance of infestation, proximity to infestation, or origin	16
Number favoring dipping, spraying or destination inspection as a substitute	9
Number of states replying (Canada included)	41

States omitted, Maine, West Virginia, Louisiana, North Dakota, Wyoming, Montana, Idaho and Washington.

For the most part, the answers to the question as to "whether fumigation of all nursery stock is required as a prerequisite to the sale of such stock from the several states" were categorically either "yes" or "no." The question with regard to the opinion of the officials upon "whether fumigation of deciduous stock is essential in view of the widespread distribution of the pest for which it was primarily designed as a control" brought forth some interesting replies and showed a divided opinion upon this point. In many cases, even where fumigation is not a general requirement for either interstate or intrastate shipment, the inspection officials felt that special circumstances of infestation, proximity to infestations or the extent to which a given territory is at present infested with San Jose Scale, should warrant fumigation as a palliative or protective measure, or from its psychological effect upon trade. Nine state officials indicated that dipping or spraying, or destination point inspection, might be substituted for general fumigation.

If it is possible to reach an agreement as to whether fumigation is desirable or not desirable in any given area of the country or over the United States as a whole, the nurserymen would welcome a standardized practice, as under existing conditions every nurseryman is beset with a multiplicity of laws and regulations to which he must conform.

Some interesting letters in elaboration of the answers to the questionnaire were received, and taking these replies as a basis certain individuals have been asked to contribute to the discussion of this topic.

MR. GLENN: Mr. Chairman, the requiring fumigation of all stock for movement or shipment seemed to me to be overdoing the subject a good deal. When I first came to Illinois they were still under some of the excitement that Mr. Reeves said might happen about the weevil getting into the Valley. The San Jose scale had gotten into the fruit growing sections and we were afraid that it was going to put an end to the fruit growing industry, so we went to the extreme, I think, in requiring all nursery stock to be fumigated. That was the regulation in Illinois fourteen years ago, but in the inspection of our nurseries, I found that there were large numbers of species and varieties of nursery stock on which we never found the scale. I do not see any justification whatever in requiring the fumigation of such trees and shrubs if they are not susceptible to the San Jose scale, unless there are some other insect pests on them which might require fumigation, but we haven't found that to be the case. We followed the practice, therefore, of eliminating from the fumigation requirement all those varieties of plants on which we have never found San Jose scale.

Then we went a little further. We found there are a great many kinds of trees and shrubs which, under certain circumstances, might be slightly infested with the San Jose scale, but if taken away from the influence of other infested trees, would free themselves of the insect, so we eliminated those from the fumigation requirements unless they were found actually infested.

In Illinois we require only certain species and varieties of plants to be fumigated which may be infested with the San Jose scale and on which the scale may persist from year to year.

We have, in Illinois, a growing feeling among our horticulturists that under certain Illinois conditions it is injurious. They follow the practice generally of spraying their apple and peach trees at the time they plant them until they come into bearing and they would rather do this than to have them run the risk of being injured by fumigation. Whether the injury is real or imaginary doesn't seem to enter into the question; they think it is real. We are now allowing our fruit growers, if they want their stock without fumigation, to substitute dipping instead of fumigation.

MR. ARNOLD: The Mississippi Plant Board, since 1918, has been requiring that all fruit stock be fumigated, regardless of whether scale has been found or not, but we haven't required the fumigation of other stock.

I agree with what Mr. Glenn has to say about requiring fumigation of stock that is not susceptible to the San Jose scale. In the South, of course, we have a lot of San Jose scale on our fruit trees, and sometimes it is found in fruit nurseries, especially on pears, peaches, apples and plums.

Back in 1918 when the plant board first required that pecan stock be fumigated, some of our pecan nurseries didn't take up with the idea. They said they had never seen any scale on pecan trees and didn't see why it should be necessary to fumigate them, but we have found the San Jose scale and also the obscure scale in several pecan nurseries, and within the last few years I understand that some of the other southern states have had similar experiences. The obscure scale has been reported from portions of Texas as a pest there. We therefore feel justified in requiring fumigation of all pecan stock. We have some large pecan nurseries in Mississippi. Some of them have nearly a hundred thousand trees. We try to inspect each tree at least once a year, then make other inspections of the nurseries, but it is easily possible to overlook some scale. For that reason I think it is well to fumigate the trees.

We feel that every man who buys nursery stock expects to get it free from scale. In fact, last year one of our nurserymen turned down a large lot of nursery stock of pecan trees because he found some live scale and a considerable number of scale marks on the trees. A few months ago the plant board amended the regulation so as to permit dipping of fruit and pecan nursery stock whenever it wasn't practicable for nurserymen to build a fumigation house, as in the case of some individual who only shipped a small amount of stock. Personally I don't believe that dipping is as satisfactory as fumigation. It probably would be if it were properly done, but the tendency among some people in dipping is to not do a thorough job, so I believe fumigation is much more satisfactory.

MR. DEAN (Idaho): I do not believe it is necessary to fumigate all nursery stock. I think there is a possibility of injury. I agree with Mr. Glenn that it is frequently safer to inspect nursery stock and dip it, if necessary, than to accept it under fumigation.

MR. SULLIVAN: A few years ago we did quite a lot of work on gas and some of the miscible oils. On the whole, I think the miscible oil

dipping probably gave us better results than hydrocyanic acid gas. Somewhat to our surprise, it was later found that we didn't kill all the scale on some of the material we fumigated and planted in the nursery. We took the matter up with some of our nurserymen who had done quite a bit of fumigating and they said they had had similar results at different times. So from those results I think that here in Missouri we probably have as much if not more faith in the miscible oil dips than the hydrocyanic acid gas, and I doubt if we run the risk of as much injury when we dip. Of course dipping can be done in several different ways. The way that most of our nurserymen dip is to dig a pit or use a barrel large enough to stick the tree down in up to the crown and then take the tree out and let it drain well. So far they haven't had any injury, and from the practice that has been carried on the last few years, I think that some of our leading nurserymen prefer dipping to fumigating.

MR. SASSCER: Naturally in the fumigation of nursery stock we should first determine whether or not the pest concerned is of such a nature as to warrant fumigation. In the second place we must know just what conditions will influence the results if we fumigate. As you all no doubt are aware, we have been fumigating nursery stock as a condition of interstate shipment for a good many years. Several years ago I took occasion to look into the formula which was being employed by the various state officials, and to my amazement I found as many formulas for the generation of hydrocyanic acid gas as we used to find for the preparation of lime sulphur; each state had its own private formula. Chemists have determined if you mix chemicals in the proper proportion you get the maximum yield of gas. Many states were putting in too much water.

One of the factors we must not lose sight of is that nursery stock is frequently fumigated at the time of the year when the temperature is such that only negative results can be expected. You can't get 100% results if you fumigate when the temperature is below forty degrees Fahrenheit. Much of the nursery stock that has been fumigated has been fumigated under just such temperature conditions where you could not expect to get satisfactory results, and doubtless that in part may account for some of the unsatisfactory results which have been referred to.

There is another point which I think is well worth considering, if we are going to require fumigation as a condition for interstate shipment. A statement should be incorporated in a certificate to the

effect that the stock was fumigated with hydrocyanic acid gas, generated by using so much cyanide, so much acid and so much water and that the temperature was at a certain point, so that one may know whether the stock was fumigated under favorable conditions. Otherwise you are simply assuming that the stock is safe because it has been fumigated, and we know very definitely that hydrocyanic acid gas will operate only under proper temperature conditions.

MR. WALLACE: There was no time this fall in Indiana when nursery stock could have beeen fumigated satisfactorily. I hold it over our nurserymen that they must fumigate if they get San Jose scale and they try to keep their stock clean. If the stock had been fumigated, 50% would have been dead, because at no time would the stock have been dry enough to be fumigated. I think the same condition held over most of the central states. You must have your stock dry when you fumigate or you will kill.

MR. HASEMAN: I might say we do not require fumigation for all nursery stock unless there is danger of scale. I think what Mr. Wallace has mentioned is really a point in favor of dipping rather than fumigation, because you can dip as long as the temperature isn't too low, whether the stock is wet or dry to begin with.

MR. BECKER: We have in our state, as every state has, a great many small nurseries. They are not equipped to fumigate, and if they were, the operation would be fraught with a great deal of danger to lives, and what is more important in the South, to the lives of their bird dogs. Now there are some who don't know anything about dipping, and I might say that to overcome this and to get the most protection the, state plant board is undertaking to give them, you might say, a bill of health if they will send us their scions to be fumigated under our supervision. We fumigate these scions and we think if they are fumigated under our supervision that they ought to be reasonably clean, and especially if the premises show there is no scale in the vicinity, which is frequently the case in isolated nurseries, they will get credit for that.

CHAIRMAN CORY: We will pass to the paper by Mr. S. B. Fracker.

THE TOURIST PROBLEM

By S. B. FRACKER, *Madison, Wisconsin.*

ABSTRACT

The unrestricted transportation of forest grown trees and shrubs in the Lake states threatens to distribute the white pine blister rust and other insect pests and plant diseases. After trying paper and manilla posters, which were not as effective as desired, the Wisconsin department of agriculture erected a series of wooden signs

along the important highways. These have attracted popular attention and greatly reduced the movement of trees and uninspected plants.

The movement of freight and passengers has undergone such a transformation within the past ten years that quarantine and inspection officers have had difficulty keeping up with developments. The number of passenger cars registered in the United States has multiplied by nearly seven during that period and the number of trucks in 1924 was over fifteen times as great as the number in 1915.

While trucks now move twelve billion ton-miles of freight per year in the United States, the more dangerous traffic in Wisconsin from the standpoint of distributing pests and plant diseases, is the movement of passenger cars. In addition to a state registration of 525,000, foreign cars to the number of 700,000 per year bring tourists to the summer resort areas of Wisconsin's forests and lakes. This traffic is predominantly, from the central Mississippi and Ohio valley states, for Michigan, Wisconsin and Minnesota receive almost all of the north-bound summer tourists from a large section of the United States.

Before 1920, this traffic was not large enough to have much effect, but about that time it became a popular fad to take a few pine and spruce trees home when the vacation was over. The following season, this was multiplied to tremendous proportions, so that a person standing on one of the important north-and-south highways in August, 1921, would have observed an apparent attempt to transplant the northern forests completely to the cities of Chicago and Milwaukee.

Nursery inspection regulations in the state cover the movement of trees, shrubs, and plants "for propagation" but it was not practicable for the department of agriculture to police the roads or forests to prevent the damage. Newspaper stories and similar educational measures were of little value, owing to the wide extent of territory from which the tourists came. Posters were therefore designed, quoting the essential sentences of the nursery inspection law, and these were put up in hotels, postoffices, and railway stations, and tacked on trees at public campsites. Through the courtesy of the Conservation Commission, all game wardens were deputized by the department of agriculture to stop tourists seen carrying trees and arrange either for the destruction of the material or sending it to Madison for inspection.

Support of this move by public organizations was even better than anticipated. As the regulations tended to limit the work of arbor day supporters and similar groups, the department looked for some criticism from these sources. The opposite has occurred, as support has been received from all organizations of this kind.

Three factors have influenced public support of the movement. First, practically all such bundles of trees are stolen. All forested land is either state or private property and the young trees constitute a valuable asset. Tourists do not take the poplar, wild cherry, and scrub oak which could perhaps be spared, but specialize on spruce, balsam, pine and occasionally elm. Second, while some of the trees thrive after transplanting, most of them do not survive the trip, as they are poorly packed and are moved in August. The practice is therefore useless and wasteful, injuring the property owner and not benefitting the tourist. Third, the material may and sometimes does carry insect pests and plant diseases. The third factor is the one in which the department of agriculture is interested but public support is due also to the other two features.

Paper and manila posters were not found sufficiently effective. The life of each was very short and the conservation wardens would not renew the ones lost during the season. To illustrate, in connection with a potato spraying demonstration, Mr. Chambers, assistant entomologist, had occasion to pass a popular camp ground at Eagle River half a dozen times during July and August, 1923. He put up a poster each time, but it was never there when he returned. Probably those posters helped build many a campfire.

The method adopted this year has proven much more effective and satisfactory. It consists of signboards along the principal highways, uniform with the official signs showing city and county limits, curves and hills. These were prepared by the painters of the highway commission, and the time and materials charged to the department of agriculture. The size is three by four feet and the total cost was just under six dollars per sign.

As the signs are double, that is, lettered on both sides, the usual method of erecting highway signs on a center post was impracticable. After studying various other types it was decided to employ the standard iron post used for the metal number plates on the state highways. The method of construction is shown in the figures. The wording is as follows: "Transporting Trees and Plants Prohibited by Law. Inspection required to prevent the spread of insect pests and plant diseases. Address State Department of Agriculture, State Capitol, Madison, Wisconsin."

Fifty signboards were prepared and placed at strategic points along the highway system. Thirty-two of these were erected in the northern counties on a two weeks trip taken by two members of the department

staff. Those in the southern part of the state were put up by the patrolmen of the Highway Commission. A detail sheet was issued to the patrolmen as the signs could not well be sent out already assembled.

While the location for the signs was worked out on a state highway map, the exact position of each was determined by the inspector or patrolman who put it up. They were placed at right angles to the center line of the road, just outside the drainage ditch or gutter. They were given conspicuous positions, not in or on the edge of a town, and not near a cross road. The larger lettering is such that it can be read easily by a driver passing at thirty-five or more miles per hour, and the sign can be read thru completely without slowing down to less than twenty-five.

The results of the new signs have been excellent. Their erection attracted immediate newspaper attention and a photograph of one of them appeared in a leading Milwaukee paper before the department had sent out an article on the subject. Clippings of stories about the signs have been received from papers in other sections also, including such points as Boston, Chicago, and Sioux City. A state fair exhibit featuring them also attracted much interest altho the tourist season was over.

The tourists, who in previous seasons tore down the posters, have taken the wooden signs to heart, for 1925 found only a very small number carrying trees. The writer was in the field on various types of work for several weeks in August and September, covering three thousand miles of state highway and only saw four tourists with such packages. One of them was stopped and it was found he had just entered the state from an adjoining one and had not yet passed one of the signboards. On the other hand, a single two-hour trip in an adjoining state showed more tourists than that with evergreens on the running board.

Of course, the results have not been perfect, as we understand there is still some movement along the eastern border of the state. About twenty-five more signs can be put up to good advantage but the greater part of the hazard has already been removed.

It should be noted that the moving of trees from the woods is not completely prohibited but that inspection is required. This is made at the Madison office of the state entomologist without charge. In 1923, however, when over six hundred cars carrying trees were stopped by conservation wardens, it was found that scarcely half a dozen cared enough for their trees to send them to Madison for inspection. Tourists would tell the warden to take the bundle off and destroy it.

The inspection policy governing such packages of forest-grown trees as do come in for inspection, is at least as stringent as that employed in the case of nursery stock. Spruce and balsam infested with the budworm are confiscated. White pine coming from north of a line drawn from Green Bay to La Crosse are destroyed altho blister rust has not been found in more than half of the counties of that area. White pine from south of that line is inspected and passed when destined for states which do not maintain a quarantine against Wisconsin white pine, as no blister rust has ever been discovered in the southern portion of the state. Two nurseries of the northern counties, one state-operated, the other private, grow white pine, but they are adequately protected by a belt of blister-rust-free territory at least fifty miles wide.

In addition to white pine blister rust, which occurs in the woods of several northwestern counties, contiguous to the infested area of Minnesota, the forests of the Lake states have several pests and diseases which might prove troublesome if accidentally introduced into other areas. Severe outbreaks of *Olene leucophaea*, a jack pine tussock moth, have occurred in 1908 and 1922. Altho wiped out after a couple of seasons by parasitic enemies, and altho confining their attack in this region to jack pine, it is possible that the pine trees of other sections of the country might find this pest one of major importance over a long period of years. The same can be said of other local pests such as the hemlock spanworm, *Ellopia fiscellaria*, now killing hemlock in Wisconsin and Michigan. The latter and its close relative have from time to time destroyed thousands of acres of hemlock in Canada. A number of other insect pests and plant diseases occur locally which might have considerably greater powers of evil in other localities.

At present there is a great diversity in the policies of the various states regarding forest-grown trees and plants. Perhaps the matter is of little importance to the prairies and the plains, but in the forested states unrestricted transportation of such material from one section to another may result in outbreaks of serious extent. In Wisconsin we are trying to prevent that happening by catching the movement at its source and the highway sign method is the one which has proven by far the most effective we have tried.

MR. ARNOLD: I would like to ask Dr. Fracker if he considers he has enough authority to stop them from taking trees across the border?

MR. FRACKER: We do and have for years, and expect to continue unless we find some very excellent reason for not doing so. Mr. Strong

expressed an opinion this morning which would lead us to believe that he thinks we are exceeding our authority. A large number of these trees go into Illinois, which state maintains a quarantine against Wisconsin white pine. If the tourists have bundles of trees and are destined for Illinois, the trees are simply taken off the car and thrown into the furnace. The matter is not a large commercial one; it is not like alfalfa.

CHAIRMAN CORY: No. 3 on the program was passed over this morning. It is reports of the Four Regional Boards on their Organization and Activities. This, we feel, is a very important matter. We have some of the regional leaders present and we want to hear from the.

CHAIRMAN CORY: Mr. Dean, we will be glad to hear from you.

THE WESTERN PLANT QUARANTINE BOARD, ITS PURPOSES AND ORGANIZATION

By M. L. DEAN, *Boise, Idaho, Chairman*

ABSTRACT

This is a history of the organization and regulations pertaining to western plant quarantines, their functions and the results which have been secured by their enforcement. The importance of quarantine regulations for the control of plant pests and the advisability of sectional organizations tending toward a central organization for better control of uniform regulations are strongly urged.

INTRODUCTORY

The consideration of plant quarantines by various states in the union as a protective measure against the invasion of new insect pests and plant diseases of agricultural crops, we find, first originated in some of the western states. California was one of the earliest in the consideration of legal action to promulgate effective quarantines. The first actual mention of quarantine procedure was in the case of grape Phylloxera in 1881. Naturally, we must presume that there was some discussion of this subject prior to its becoming effective. The actual machinery for the operation of quarantine protection had serious obstacles thrown in its way but experiences were gained between 1881 and 1899, when the State Horticultural Quarantine Law was passed, which proved of exceptional benefit, and by 1900 we find the work on a very firm foundation. At that time inspections were being made of plant materials entering the maritime ports of California. This insured a protection not only for that state but for neighboring western states, and, as a matter of fact, for a large portion of the United States which received plants entering through California from Australia, the Hawaiian Islands and the Orient.

The greatest impetus was given to plant quarantine in the Pacific and Rocky Mountain states with the introduction and spread of the alfalfa weevil into Utah. Inasmuch as alfalfa had become an economic crop of major importance, the western states were keenly anxious to keep this pest out, which resulted in the passage of a great variety of quarantines. The bulk of these became effective in 1912 and 1913 and because of a lack of uniformity there were many disagreements. In addition, actions were taken that in many instances were excessively overdrawn, quarantines were placed against commodities which were not recognized as being a menace and other commodities were not covered which should have been. Conferences were held between individual states, developing discussions of what were reasonable measures.

Another subject causing considerable interest in quarantine measures was the potato tuber moth, several of the states which had developed a considerable potato production were endeavoring to protect themselves against the introduction of this potato pest, which, at that time, was very common in California. Some of the states were still of the belief that quarantines were being enacted for commercial purposes and it was not uncommon to hear of the terms "retaliation" or "commercial embargoes" used in a threatening attitude.

About this same time the Federal Plant Quarantine Act of 1912 had been passed by Congress as a result of many years of work on the part of those in Washington who recognized the necessity for protecting the entire nation against pests that the various states themselves, had been watching for, or had been successful in keeping out. The states looked to the Federal Horticultural Board, which was created by this Plant Quarantine Act, as an agency that would be of exceptional assistance to them, and all who had had some experience with quarantine enforcement hastened to cooperate to the fullest extent. By this time there had been much valuable information developed as to the whys and wherefores of plant quarantine action, and it was no longer looked upon as anything particularly novel.

In 1918 a meeting of representatives of all of the western states was called together with the Federal Horticultural Board in conference which helped to iron out many of the difficulties and disagreements which had been encountered. At this conference a start was made toward a unification of plant quarantine ideas and principles which brought about a start toward uniformity in quarantine action. It was first necessary to dispel the idea that plant quarantines were placed for commercial purposes; it was necessary to discontinue the beliefs that

competition was a thing to be prevented by quarantines, and it was necessary to prevent the interference with interstate traffic where reasonable action would allow the normal intercourse of trade to be interrupted only when absolutely necessary. We must confess that even at this time there was not sufficient distinction made between which quarantines should be prohibitive and which should be restrictive.

Following this conference letters were sent to the quarantine officials of the western states, suggesting the necessity for a conference on the subject and setting forth some of the problems that made such a conference vital. Favorable responses were received and a conference of quarantine officers was called. The plan was favorably considered and in May, 1919, delegates from the eleven western states, including British Columbia, the northern State of Lower California, Mexico and the Hawaiian Islands came together at Riverside, California. In attendance at this first meeting were quarantine officials from Arizona, California, Colorado, Idaho, Montana, Oregon, Utah, Washington, Hawaii, British Columbia and Lower California. It was gratifying to note that by this time several of the states had developed a well founded system of quarantine protection.

This conference had accomplished such good that it was desirable to permanently organize a committee for the purpose of unifying quarantine action in the West, and as a result the Western Plant Quarantine Board was formed, a constitution and by-laws adopted, with chairman, vice chairman, and secretary-treasurer as the permanent officers.

The purpose is set forth in Article II of the Constitution and By-laws as follows: "It shall be the purpose of this organization to secure a greater mutual understanding, closer cooperation and a uniformity of action for the efficient protection of our plant industries against plant diseases and insect pests."

Organization

The Western Plant Quarantine Board, as at present constituted, consists of all of the states west of a line drawn along the east borders of the states of Montana, Wyoming, Colorado and New Mexico, and in addition, British Columbia, the northern State of Lower California, Mexico and the Hawaiian Islands.

The officers, chairman, vice chairman and secretary-treasurer, previously were elected every two years but at the present time are elected annually.

There have been seven conferences held in six different states.

The first meeting brought out comprehensive discussions on the fol-

lowing subjects: (1) Quarantines, their purpose and how they may best be imposed and enforced; (2) The Federal Horticultural Board and the Plant Quarantine Act of 1912; (3) Interstate quarantines pertaining to alfalfa weevil; (4) Potato tuber moth; (5) White pine blister rust; (6) Nursery stock inspection, and (7) The pink bollworm situation. Other matters of general interest were brought up. It is singular that these subjects discussed at the first meeting have run through the following sessions, each session showing a higher plane of discussion as the conferences have been held.

The representatives of the states are not all the same as were in attendance at the first meeting but there is a nucleus of those at the present time who were in attendance at the original conference.

We can better give an idea of the organization by stating some of the accomplishments.

1. A better understanding of quarantine principles on the part of the enforcement officers of the various states.

2. Personal acquaintanceship and contact between quarantine and inspection officials. This is an important consideration when carrying on correspondence, because a personal acquaintanceship gives an exceptional idea of the disposition and temperament of the individual with whom you are dealing. It further is a valuable advantage in taking up matters of general interest where plant quarantine is not necessarily the topic under consideration.

3. An opportunity is afforded at the annual meeting for those interested in cooperating with the various states to meet the group collectively and to gain complete discussion on a subject, whereas, correspondence might leave serious questions and doubt in the minds of various individuals.

a. The Federal Horticultural Board has an opportunity to bring its problems to the attention of the western states. Dr. Marlatt, Chairman of the Federal Horticultural Board, has attended a number of these meetings, and as a result there has been an exceptionally fine understanding between the states and the Board and full cooperation has been forthcoming. At our Denver meeting in 1924 the results of the Plant Quarantine Conference in Washington in April were brought to the attention of the members, resulting in the immediate adoption of the basis of agreement, which was an important step. This basis of agreement embodied many of the principles that the Western Plant Quarantine Board has been following.

b. Complete reports were given on the quarantine conditions in

the various states, the experiences gained by some being of direct advantage to others. Local problems that are encountered often are given solutions as a result of the experience of the various states collectively.

c. The U. S. Post Office Department has sent representatives to all of the meetings, which has resulted in very fine arrangements for the inspection of parcel post and mail matter under the provisions of the Postal Inspection Law pertaining to plants and plant products. Mr. William C. Wood, Superintendent of Classification, who is directly in charge of work of this nature, has met with the conferences several times.

d. Developments in pest control procedure are fully expounded. For example: Vacuum fumigation, which has been developed by an entomologist of one of the member states, has resulted in modifications of quarantine action to a basis of certification where previously an embargo was enforced. Treatment of citrus nursery stock for scale insects and potatoes for tuber moth by vacuum fumigation has proven conclusively that it is a procedure which can make the entry of host plants of these pests safe.

e. Information on new insect pests and diseases introduced into the several states is brought out and information as to new crops which are attacked by some of the pests previously present always proves to be of value.

f. Consideration is given as to how best certification of plant commodities for entrance into another state can be brought about and the features governing proper certification considered.

4. Committees are appointed to report on certain subjects and to accomplish certain ends; for example, a committee to investigate and suggest methods of automobile and auto camp inspection; a committee on uniform crop pest surveys; a committee on the codification of quarantine laws, orders and regulations for the states concerned; a committee to draw up specific quarantines for uniform adoption by all of the states; special attention to transportation company problems is given.

5. The western states can act as a unit in problems of vital concern. For example: At the recent plant quarantine hearings at Washington in November 1925, a quarantine committee appointed by the Director of Agriculture of California was given power of attorney to act for the Western Plant Quarantine Board. This meant the support of the eleven western states and gave a support to the Federal Horticultural Board

that was of no mean consequence in averting possible disaster to the provisions of the Plant Quarantine Act.

6. Some uniform quarantines have been adopted. For example: Chestnut bark disease has been quarantined against by seven of the eleven states, definite arrangement having been reached whereby four of these states would not consider the quarantine burdensome if they were included in the quarantined territory. Further, the experiences of one of the states in the enforcement of quarantines are taken as essential information by another state contemplating an amendment or a change in its regulations.

7. A News Letter has been developed which is issued from time to time as information pertaining to quarantine and other matters vital to the member states and provinces is assembled.

8. Certification of commodities as to freedom of pests and diseases is recognized as being based on the integrity of the inspection officials and is further based upon actual findings and not upon general considerations without competent investigation.

9. A Transportation Plant Quarantine Committee has been formed, consisting of the chief transportation lines operating between the various states, resulting in the appointing of one responsible official from each of these lines with whom contacts can be made. Transportation representatives meeting with the Western Plant Quarantine Board gives an opportunity to discuss subjects with an individual who has developed a knowledge of quarantine principles and purposes. This is an invaluable aid and precludes the taking up of matters with an official who has no knowledge of the subject.

10. In the event of a hearing in Washington or in one of the member states pertaining to a subject of general interest, the representative in attendance can report his conclusions to the other states the same to be taken as a basis for information.

11. Cooperation in the investigation of specific subjects on the part of one of the member states which carries the investigation into the territory of another. This cooperation has been extended in a number of instances, making it possible for those conducting the investigation to have many arrangements made whereby the investigation can be consummated in the shortest possible time. For example: Recently an investigation was made of the possibility of alfalfa meal being safely admitted into states embargoing this commodity. The quarantine officials of the state making the investigation were readily able to consummate their efforts in a few days time, whereas, if working alone and

without the cooperation of the officials of the other state it might have taken weeks.

Conclusion

The members of the Western Plant Quarantine Board believe that there has been no other medium of such consequence or importance that has simplified the understanding and cooperation between states. It has given an opportunity for uniform dealings throughout and has been a means of actually building up protective work as a unit for the West and for fostering protective work in some of the states where it perhaps would still be in initial stages. Personal contact is one of the outstanding features and a full knowledge of the problems of the individual states by all of the members. Close cooperation of all interests in the various states toward uniform action is the only way that the best protection can be given to each state without injury, letting justice to all and malice toward none be our maxim.

Chairman Cory: I think there is no doubt that the Western Plant Board was the inspiration for the retiring chairman last year in his efforts to have the other regions of the country organized and in turn form a national board of review with members from the various states. I understand that the central states have organized. The middle Atlantic and northern states have organized, and I believe some steps have been taken to organize the southern states. I believe Mr. Glenn has a report.

REPORT ON ACTIVITIES OF THE CENTRAL STATES ADVISORY PLANT BOARD

In accordance with the recommendations of the Committee on United States tag for interstate shipment of nursery stock, adopted at the Washington meeting of the Section of Horticultural Inspectors, representatives of seven of the North-Central States met at Lafayette, Indiana, March 6, 1925, at the call of Dr. S. B. Fracker, Chairman of the Committee appointed to effect the organization.

An organization was formed under the name of "Central States Advisory Plant Board" by the adoption of a constitution and the election of the following officers:

For President—A. G. Ruggles, St. Paul, Minnesota.

For Secretary—P. A. Glenn, Urbana, Illinois.

For Members of the National Board of Review—

Frank N. Wallace, Indianapolis, Indiana, 3 year term,

S. B. Fracker, Madison, Wisconsin, 2 year term.

The constitution and by-laws follow:

CONSTITUTION

ARTICLE I

The name of this organization shall be "Central States Advisory Plant Board."

ARTICLE II

The purpose of this organization shall be to promote uniformity and efficiency in horticultural and quarantine regulations.

ARTICLE III

SECTION 1. The members of this association shall be the horticultural inspectors and quarantine officers of the following states: North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Ohio and Kentucky.

SECTION 2. Each state shall be entitled to one vote; this is to be cast by the chief horticultural inspector or his representative. Where a state has two officers of equal authority present at any meeting, each shall be entitled to one-half vote.

ARTICLE IV

SECTION 1. The officers shall consist of a president and a secretary whose duties shall be those usually assigned to these officers.

SECTION 2. The executive committee shall consist of the officers, together with the two members of the National Board of Review from the central states.

SECTION 3. The officers shall be elected at each annual meeting for the ensuing year. Each member of the National Board of Review shall be elected for a three year term except that one member elected at the 1925 meeting shall serve for a term of only two years.

SECTION 4. The duties of the executive committee shall be to consider pertinent matters which arise between regular meetings and advise the members thereon.

SECTION 5. The president may appoint special committees to investigate and make recommendations on specific problems.

ARTICLE V

The constitution and by-laws may be amended at any regular meeting by a three-fourths vote of those present.

BY-LAWS

ARTICLE I

The entomologists, plant pathologists, and quarantine officers of Canada, of the U. S. Department of Agriculture and of the various experiment stations and agricultural colleges are invited to attend the meetings of this organization and are entitled to the privileges of the floor. Other parties in interest may be invited to attend by the officers.

ARTICLE II

The time and place of the annual meeting shall be determined by the executive committee. It shall be the policy of the organization to hold its annual meetings with the entomologists of the North-Central States.

Date Signed	State	Signature
March 6, 1925	Illinois	P. A. Glenn
March 6, 1925	Indiana	Frank N. Wallace
March 6, 1925	Kansas	J. W. McCulloch
March 6, 1925	Michigan	L. R. Taft
March 6, 1925	Missouri	L. Haseman
March 6, 1925	Ohio	Richard Faxon
March 6, 1925	Wisconsin	S. B. Fracker
March 25, 1925	Kansas	H. B. Hungerford
March 26, 1925	Minnesota	A. G. Ruggles
March 26, 1925	South Dakota	H. C. Severin
March 27, 1925	Nebraska	Myron H. Swenk
April 11, 1925	North Dakota	R. L. Webster
April 14, 1925	Iowa	Carl J. Drake
	Kentucky	

Copies of the constitution and by-laws were submitted to the proper officials of the other states, namely: Nebraska, North Dakota, South Dakota, Minnesota, Kentucky and Iowa and were, with the exception of Kentucky, signed on the dates mentioned above.

Horticultural inspectors and plant quarantine officers which were present at the meeting and authorized the secretary to sign their names to the constitution and by-laws were as follows:

P. A. Glenn, Urbana, Illinois.
Harry F. Dietz, Indianapolis, Indiana.
Frank N. Wallace, Indianapolis, Indiana.
J. W. McCulloch, Manhattan, Kansas.
L. R. Taft, Lansing, Michigan.
L. Haseman, Columbia, Missouri.
Richard Faxon, Columbus, Ohio.
S. B. Fracker, Madison, Wisconsin.

The only problem that has come up for solution is in connection with the alfalfa weevil. A committee was appointed to draw up a quarantine which should be acceptable to the authorities in the North-Central States and recommend it for adoption. At least four of the states have already issued quarantines practically uniform with that recommended by the committee.

There is a practical unanimity of sentiment among the inspectors of the central states and it is confidently expected that through the Central States Advisory Plant Board greater efficiency and uniformity of action will be promoted, as well as closer cooperation.

P. A. GLENN, *Secretary*,
Central States Advisory Plant Board

CHAIRMAN CORY: If you will permit me, I will make a report for the middle states and northern conference board, in view of the fact that Dr. Headlee, the chairman, is not here.

Our organization was completed in October, with all of the states from Virginia northward to the Canadian line included in the organization. Dr. Headlee was made permanent chairman and Dr. McCubbin and Professor O'Kane selected as representatives to the National Board of Review. The speaker was selected as secretary of that organization and we had hoped we would be able to get a National Board of Review organized at this session. I feel it is one of the most important steps we have ever taken in making for uniformity and efficiency in plant pest control.

MR. R. W. HARNED: I believe that the committee appointed last year by the retiring chairman was appointed after the meeting of the Cotton States Entomologists. Dr. Newell of Florida is chairman of the committee and has not had a meeting, so far as I know. It is my guess that when the Cotton States Entomologists meet in February in Atlanta, a southern quarantine board very similar to those we have heard described this afternoon will be organized in the southern states. I believe the territory assigned begins with North Carolina and includes Texas.

MR. BECKER: I haven't anything to say other than the Cotton States Entomologists have for some years functioned as a body without a constitution or by-laws or anything else, and we have held frequent meetings for a great many years. We have coordinated our regulations to a very large extent, and I think the actual creation of this board will facilitate matters considerably, but we have already made considerable strides, I think.

MR. STRONG: Mr. Chairman, I attended the meeting last winter of the Cotton States Entomologists in Atlanta and submitted this idea of forming a southern quarantine board. It seemed to be the idea of the members in attendance there that inasmuch as they had a working organization and met each year at a stated period, they could very logically take over that work, but it seemed necessary there should be a committee appointed to make recommendations back to the Cotton States Entomologists and to this group. I believe Dr. Newell, Professor Harned and one other member were appointed for that purpose. Unfortunately, none of the members were at the meeting of the Cotton States Entomologists.

We did have a meeting of the quarantine officers of the southern

states. Mr. Arnold was there, and several others, and the idea seemed to meet with very great favor. I went away from there with very great hopes that it would be accomplished, that they would form this organization, and I feel confident that the Cotton States Entomologists will take over this work.

CHAIRMAN CORY: We have two committees to report, and then the election of officers. Mr. Sasscer, will you report for the Committee on Nominations?

MR. SASSCER: Mr. Chairman, this has been indeed a very gratifying meeting. It has been my pleasure and privilege to attend the meetings of the Section of what was formerly known as Horticultural Inspection for many years, but to my knowledge this is the first time that we have been so fortunate as to have so many in attendance from the Western Plant Board. I believe there are some five states out of a total of eleven represented here today. In view of this situation, it is the feeling of the committee that it would be desirable in making the nomination for next year to honor the Western Plant Board, and in so doing, honor ourselves. We have, therefore, unanimously decided to recommend for Chairman for next year a man who is outstanding in quarantine work. It is with great pleasure that we recommend Mr. Lee A. Strong of Sacramento, California, for Chairman, and Mr. W. B. Wood, the present incumbent, as Secretary for the ensuing year.

CHAIRMAN CORY: You have heard the report. What shall we do with it? The report was accepted and the nominations adopted.

MR. STRONG: Mr. Chairman, I am very appreciative of the honor and I tried to get your attention before you put the vote. I feel that the President of this Section should be somewhere in the East so he could be in contact with the Secretary; as the next two or three sessions of the Association are to be held in the far East, it would seem desirable that the President should be in a position to assist the Secretary in arranging the program. It is not at all certain that I shall be able to attend these meetings as regularly as those quarantine men and entomologists who are located in the East. In fact, I was told a few months ago if I expected to draw any more salary from California I would have to spend a little more time in that state. I have been east three times in less than three months and my people out there are getting a little exercised over my globe-trotting habit.

However, if it is the wish of the Section, I certainly appreciate the honor and will do everything I possibly can to make the next meeting at least as successful as this one.

CHAIRMAN CORY: We will next hear the report of the Committee on Resolutions. Mr. Fracker.

MR. FRACKER: Mr. Chairman, the Committee has a number of resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Be it Resolved, That the Section of Plant Quarantine and Inspection record in its proceedings our recognition of the valued services and ability of the deceased member, Dr. W. D. Hunter, in whose sudden death the Section keenly feels the loss not merely of a leader in his chosen field but of a valued friend and co-worker.

Appreciating the long and most valued services of Professor H. A. Gossard; be it *Resolved*, That this Section express to his wife and family our deepest and sincerest sympathy. In Professor Gossard's death this Section loses one of the best known and leading contributors to economic entomology. We shall especially miss his cordial friendship and the stimulus of his strong personal influence.

Be it Resolved, That copies of these two resolutions be transmitted to the relatives of Professor Gossard and Dr. Hunter and spread on the minutes of this Section.

Be it Resolved, That greater cooperation and increased uniformity are desirable in plant quarantine matters, and it is recommended that the spread of the insect and plant disease outbreaks be retarded so far as possible by effective restrictions placed by the authorities of the infested states on the movement of susceptible materials from the infested localities to all other points.

Be it Resolved, That entomological exhibits, particularly those dealing with introduced pests, are a most important feature at the annual meeting of the Section on Plant Quarantine and Inspection, and that such exhibits should be supported and encouraged in every practical way and should be installed in rooms adjoining those in which the entomological meetings are held. The Section recommends that the Association of Economic Entomologists appoint a committee to confer with the officers of the American Association for the Advancement of Science regarding such plan.

Be it Resolved, That the solicitor of the United States Department of Agriculture be asked his opinion on the following questions, and that the Secretary of this Section be instructed to transmit his reply to the Plant Quarantine officers of the various states:

1. In the absence of a federal quarantine on a particular subject, does the state in which an insect pest is present have authority under the Federal Constitution to prevent the shipment of materials susceptible to infestation from the infested area to points outside the state for the protection of an outside State.

2. Does the reply to the first question depend on whether such shipments while enroute would or would not threaten to carry a possible pest to an uninfested area of the state of origin?

3. In a case in which the federal government has established a quarantine covering a particular pest, is a state thereby prevented from placing an embargo against the importation of material subject to infestation from areas greater than those covered by the federal regulations.

The motion to adopt the report was seconded and carried.

A motion to adjourn was seconded and carried and the meeting adjourned at five-thirty.

A SURVEY OF THE CORN BORER SITUATION IN 1925

Submitted by: L. H. WORTHLEY, *Administrator in Corn Borer Control, U. S. Bureau of Entomology*

ABSTRACT

This paper consists of an account of the present status of the investigation of the European corn borer (*Pyrausta nubilalis*), with special reference to dispersion, quarantine and inspection, scouting, and control measures. While the spread in New England and Eastern New York during 1925 was small, the infested area in the states bordering on Lake Erie, viz., Western New York, Pennsylvania, Ohio and Michigan was increased to 30,237 square miles. The states of Massachusetts, Pennsylvania, Ohio and Michigan have adopted compulsory clean-up regulations and much good has resulted from their enforcement. Progress has been made in the development of machinery for cutting corn close to the ground in order to prevent the establishment of strong colonies of the borer. Experiments with spring and fall plowing to determine the effect as a control measure are being conducted. During the season of 1925 a total of 2,427,020 automobiles were inspected at intrastate quarantine lines and 171,502 ears of corn confiscated. 1972 corn borers were taken from the confiscated corn, much of which was destined for points several hundred miles outside the infested area. Scouting was prosecuted during 1925 on a larger scale than in previous years.

A survey of the European corn borer situation during the year 1925 shows a condition which has caused alarm to many agriculturists. While conditions prevailing in the older infested areas in New England are not so bad as in 1922, the intensity of the infestation is more than twice as great as in 1924. In the Lake Erie region the last two years certainly have been "corn borer years" and an extensive spread has occurred. No dispersion of consequence has developed from the quarantined area in New England. During the past three years a light infestation has existed in the state of Connecticut, bordering Long Island Sound, but these sections have been thoroughly cleaned up each season and the towns have not been placed under quarantine. The state authorities of Connecticut have cooperated in every way possible to prevent increase and spread. Clean-up work has been conducted each year in the lightly infested area in the vicinity of New York City and the infestation has not increased to any extent. A great deal of sweet corn is grown in the township of North Hempstead, Long Island, and a slight increase in corn borer infestation has been noted there this year because of the failure of a local farmer to clean up his cornstalks and stubble. Burning work to counteract any further increase was done during 1925. In South Brooklyn, where the corn borer occurs mostly on weeds, the rate of infestation shows a decrease from that of last season. The Staten Island area remains about the same as in 1924,

approximately forty borers having been found in different locations. A new infestation was discovered last summer at Bayonne, on the New Jersey shore, a short distance from Staten Island. Weeds and grasses are the principal host plants in the infested areas in the vicinity of New

Fig. 12.—The black shows areas in the United States and Canada infested by the European corn borer.

York City, except at North Hempstead, where corn as well as sweet corn has been attacked. Panic grass and smartweed ordinarily are the principal hosts. The infestation existing in the vicinity of Albany, New York, remains about the same in size and intensity.

The spread in Ohio has not been extensive, but in western New York, Pennsylvania, and eastern Michigan it has been enormous. In the infested area from Buffalo, New York, south to Fredonia, the intensity of infestation during 1925 so increased as to cause some loss of sweet corn to growers and also added to the cost of canning, in some instances doubling it. Infestation in northwestern Pennsylvania has increased but not to such an extent as to cause commercial loss. In Ohio there has not yet occurred what might be termed commercial damage, but in some sections the increase in density has been great, considering the light infestation existing in 1924. A few fields in Michigan showed increased numbers of the corn borer but not so many as in Ohio. Michigan

has no heavy infestations at the present time but there is great danger of further invasion from the Canadian side, where severe infestations exist in the counties of Essex and Kent, situated not more than 25 miles from some of the Michigan cornfields. Early last spring there was a demand for compulsory legislation to clean up standing cornstalks, high stubble, and corn remnants around farm buildings. The department of agriculture of Ohio promulgated a regulation compelling those residing in the areas infested previous to 1924 to destroy all cornstalks, corn remnants, and corn stubble more than six inches high. A much better cleanup was accomplished than in previous years and much good resulted; although in my opinion, the regulations were not as strict as they should have been.

In July, 1925, a conference was called of regulatory officials representing the Lake Erie region, the Canadian government, and the Federal Department of Agriculture, at which the following regulations were adopted by the states of Pennsylvania, Ohio, and Michigan:

Sweet corn stalks must be cut at a height not to exceed two inches, within two weeks after the ears are harvested, removed from the field and either fed direct to live-stock or made into silage or shredded or burned, or plowed under while green.

Field or silage cornstalks must be cut as low as possible, and not to exceed six inches in height, and should be removed from the field soon after, if possible. If impracticable to cut cornstalks at the before mentioned height, such stalks must be broken off at a level with the soil surface during the winter, using preferably a heavy pole or metal rail for that purpose, then raked into windrows in preparation for destruction by burning.

All cornstalks, corn cobs, and other corn remnants, not including silage, remaining on premises must be destroyed by burning on or before May 15 of each year; therefore, these cornstalks, corn cobs, and other corn remnants, unless finally shredded, should be kept separate from manure piles and away from barn yards.

New York preferred to use moral suasion rather than mandatory regulations.

While these regulations are not as stringent as we believe they should be to accomplish the best results, a handicap existed because farmers could not purchase suitable machinery to cut corn close to the ground. Nevertheless, much benefit has been derived from these measures.

In Massachusetts, the state law compels farmers to plow under cornstalks and corn stubble to a depth of at least six inches before December 1 of each year. This season the authorities have been extremely successful in enforcing this regulation. A small number of farmers have failed to comply and the state is prosecuting the delinquents.

Because of the lack of machinery which would cut cornstalks close to the ground, a necessary method in the suppression of the corn borer,

a cooperative arrangement was made with the engineering department of Ohio State University to conduct experimental work on a corn harvester which would cut the stalks not higher than one inch from the ground. The result has been the development of a machine which will do this work so successfully that nearly all of the large manufacturers of farm implements are now working to develop similar attachments for their corn binders. Those who cooperated in the experiments were the Ohio State Department of Agriculture, the Ohio State Experiment Station, and the Bureau of Entomology of the United States Department of Agriculture.

The investigational branch of our work, under the direction of Mr. D. J. Caffrey, in cooperation with the Ohio State Experiment Station, is now conducting an important experiment with spring and fall plowing to determine their effect in the suppression of the European corn borer. The results of this experiment should have an important bearing on the work of control.

Percentage count work, made to determine the density of the corn borer infestations, has been conducted in the past on a small scale, but this year it was decided to enlarge this phase of the work. The Control and Investigational forces cooperated with the states concerned in covering the entire western area of infestation, working every other town, checker-board style, in the Lake Erie region. The results were as follows:

NUMBER OF LARVAE PER 100 STALKS

New York	3.6
Pennsylvania	2.7
Ohio	1.9
Michigan	1.5

In connection with this work, Mr. Caffrey gave me some interesting figures on stubble infestation in the Bono district of northwestern Ohio:

Of an area of 29 fields, containing 177 acres, 10 fields were machine cut and 19 were hand cut. The shortest stubble was 8 inches and the highest 21 inches. The average height was 13.5 inches.

Estimated number of stubble in the 29 fields	1,746,977
Estimated number of infested stubble	128,996
Estimated number of larvae in stubble	143,839
Average per cent of stubble infested	7.38
Average number of larvae per infested stubble	1.1
Total number of larvae per 100 stubble	8.1

TENTATIVE SUMMARY OF FIELD COUNTS—1925.

Ohio, New York, Pennsylvania, Michigan

Number of townships	302
Number of fields examined	1,496
Total acreage examined	8,452.5
Total number of stalks in area examined	100,763,263
Total number of stalks examined	752,900
Estimated number of infested stalks in area examined	1,364,534
Estimated number of larvae in area examined	2,125,609
Average per cent of stalks infested	1.35
Average number of larvae per infested stalk	1.56
Total number of larvae per 100 stalks	2.11

AUTOMOBILE INSPECTION AT QUARANTINE LINES

The inspection of automobiles at intra-state quarantine lines was in operation during the season of 1925 on a much larger scale than in the previous year. Such lines were operated in southwestern New York, adjoining the state of Pennsylvania, in the northwestern part of Pennsylvania, along the border of the infested region of Ohio, and in eastern Michigan, where a determined effort was made to prevent the artificial spread of the European corn borer into uninfested areas. All vehicles leaving the infested area were stopped at the quarantine lines established by the departments of agriculture of the respective states and searched. All corn products, especially roasting ears, were seized and eventually destroyed (unless claimed for use within the quarantined area). A total of 87 lines were operated in these four states.

Pennsylvania passed a special law at the last session of the legislature empowering inspectors to stop and search vehicles leaving the intra-state quarantined area. This law proved valuable. Automobilists refusing to stop after signal were summoned into court. Convictions were secured in several instances and fines were imposed. Motorcycle officers were used to check travel on many of the byroads and their efforts resulted in several prosecutions. Taken as a whole, this inspection of automobiles was successful and undoubtedly prevented long-distance spread.

The following figures will illustrate the extent and magnitude of this work:

In 131 instances corn was taken from automobiles whose destination was more than one hundred miles from the quarantine lines, and in two cases corn destined for points 300 miles away and infested to the extent of 25 European corn borers, was prevented from leaving the quarantined

area. The destinations of many machines carrying corn products were Chicago, Illinois, and points in the states of Indiana, Kentucky, West Virginia and Maryland.

Number of cars stopped in—	
Ohio	1,418,829
Michigan	700,263
Pennsylvania	258,762
Western New York	49,166
Total	2,427,020
Number of ears of corn taken from these cars.	171,502
Number of corn borers in corn taken at quarantine lines	1,972
Number of inspectors employed at lines	258

Honor System

As in 1924, the "honor system" was in force in connection with the inspection of automobiles, except trucks, and it proved even more effective than it had previously. Under this system all vehicles passing the quarantine lines are stopped, inspected and the drivers are given a folder explaining the nature of the work against the pest together with a card for the owner to fill out later and mail to our Cleveland office, pledging himself not to carry corn in any form from within the area to points outside. When these cards are received and recorded, a marker is mailed to the signer, which may be fastened to the lower right hand corner of the wind shield of his car. When these vehicles later pass through the lines, it is only necessary for them to slow down sufficiently for the inspector to see the marker, and they are allowed to proceed without further inspection or delay. This system causes less annoyance to the motorist and less work for our inspectors. During the season of 1925, 31,034 such markers were issued. Reasonable precautions, of course, are observed to prevent violations of the quarantine through mis-use of the markers.

Scouting

Scouting work to determine new spread of the European corn borer was carried on in 1925 on a larger scale than in previous seasons, two hundred scouts being engaged in this work in the entire area.

A scouting crew usually consists of two to five men with a small motor truck and general supplies, especially maps made expressly for this work. Our method is for a crew to scout a town or township for one week and if no infestation is then discovered to move to the adjoining unscouted town. When infestations are found, specimens are mailed in special containers to the laboratory and if these are determined to be

European corn borer, the crew immediately moves on to the next township. All specimens are determined at the Government laboratories.

The scouting work in the western area usually starts after the fourth of July and continues until October 1 or later. In New England, the scouting period is from Labor Day in September to December 1. Weed scouting is done much better late in the season. During the past season the farmers were quite eager and willing for our scouts to examine their corn, for they are becoming familiar with the fact that the European corn borer is an insect pest of prime importance. During the past two seasons, we have been fortunate in securing scouts with entomological training who are students at agricultural schools. A large proportion of these boys were reared on farms, know what hard work is, are interested in the project, and take kindly to our working regulations. The following table gives the number of specimens submitted to the laboratory which were determined as the European corn borer and also the number determined as other than the corn borer.

State	European corn borer	Not the European corn borer
*Massachusetts	315	1
*Maine	56	—
Connecticut	56	509
Rhode Island	3	2
Eastern New York (Albany)	2	—
Long Island, N. Y.	125	733
Brooklyn, N. Y.	11	663
Staten Island, N. Y.	39	441
New Jersey	12	396
Western New York (Buffalo)	514	94
Pennsylvania	581	182
Ohio	225	138
Michigan	199	3
	2,140	3,162

*Markets and field inspections combined.

	Number of acres scouted	Area in Sq. Mi.	Number of fields	Man Days	Miles Traveled	Number of European corn borers found
W. Area	41,303	17,555	9,162	5,512	56,411	959
W. N. Y.	7,856	3,559	3,803	742	12,896	514
N. E.	7,599	1,206	9,522	1,105	11,788	159
Totals	56,758	22,320	22,487	7,359	81,095	1,632

A large number of exhibits depicting the various stages of the European corn borer have been placed in agricultural high schools in the west-

ern districts and much interest has been manifested in them, especially by the parents of pupils, a special day having been set for them to attend. Corn borer exhibits have been shown at all county fairs held within the infested area and experienced men explained the general methods of control.

Number of exhibits placed in schools	51
Attendance	7,000
Number of exhibits shown at state and county fairs	47
Meetings attended	127
Total attendance at meetings	11,000

These meetings were generally arranged by Extension workers, and the European corn borer moving picture film and a scenic film were shown.

SPECIAL REPORTS PREPARED UNDER THE DIRECTION OF THE SUB-COMMITTEE ON INSECTICIDES AND APPLIANCES, COMMITTEE ON POLICY

Report on Oil Emulsions

To the Committee on Policy:

Your sub-committee, appointed to summarize and so far as possible standardize oil emulsions, reports as follows:

A year ago this committee made its first report, based on questionnaires sent to entomologists and others in various states and provinces in the United States and Canada. This year a similar questionnaire was sent out and replies with data were received from the following: *Western States*—B. B. Fulton, Corvallis, Ore.; H. E. Woodworth, California Spray-Chemical Co.; I. M. Hawley, Logan, Utah; Leroy Childs, Hood River, Ore.; Geo. M. List, Fort Collins, Colo.; E. R. deOng, Berkeley, Cal.; H. J. Quayle, Riverside, Cal.; E. O. Essig, Berkeley, Cal.; R. S. Woglum, California Fruit Growers Exchange, Los Angeles, Cal.; J. R. Parker, Bozeman, Mont.; E. P. Venables, Vernon, British Columbia; Claude Wakeland, Parma, Ida.; E. J. Newcomer, U. S. Bur. Ent., Yakima, Wash.; D. C. Mote, Corvallis, Ore.; *Eastern States*—S. W. Frost, Arendtsville, Pa.; Penn. State College, State College, Pa.; P. J. Parrott, Geneva, N. Y.; J. L. Baskin, Horticulturist, Knoxville, Tenn.; O. I. Snapp and C. H. Alden, U. S. Bur. Ent., Fort Valley, Ga.; W. P. Flint, Urbana, Ill.; B. A. Porter, U. S. Bur. Ent., Vincennes, Ind.; A. J. Ackerman, U. S. Bur. Ent., Bentonville, Ark.; Philip Garman, New Haven, Conn.; W. W. Yothers, U. S. Bur. Ent., Orlando, Fla.; L. Caesar, Guelph, Ontario; L. Haseman, Columbia, Mo.; Bureau of Plant Industry, Harrisburg, Pa.; W. A. Ross, Vineland Station, Ontario; J. J. Davis, Lafayette, Indiana.

The information contained in the questionnaire answers is summarized as follows:

Question 1.—What oil emulsion formula have you found most satisfactory?

There was a rather definite difference in the replies from the Eastern States and those of the Rocky Mountain and Pacific Slope areas. In the east the original boiled lubricating oil emulsion was recognized as the most generally satisfactory. The reasons for its preference over the cold mixed emulsions were its more complete

emulsification and stability, the stock emulsion could be prepared days in advance, it is apparently more foolproof, and the additional fact that commercial concerns are preparing a good stock emulsion at a reasonable cost and most growers prefer the ready prepared emulsion at a slight additional expense than to bother with its preparation.

In contrast to the opinion of the majority in the eastern states, the western states showed a majority favorable to the cold mixed emulsion and of the two or three cold mixed emulsions referred to the preference was decidedly for the calcium caseinate emulsifier. The reason which seemed to underlie the preference for the cold mixed was that there was universally less difficulty where "hard" water was used, a problem which cannot be overlooked in many of the western states. There seems to be little difference in the effectiveness of the boiled and cold mixed emulsions but occasionally difficulty in making a good cold mixed emulsion unless the caseinate is quite fresh. The fact that calcium caseinate a year old is often unsuitable for preparing emulsions makes it important that formulae specify fresh material. Because of difficulties with the boiled emulsion where only hard water is available and difficulties with the cold mixed emulsion where old calcium caseinate is used, several preferred the copper sulphate emulsifier. The formula for this is one gallon of oil, two to four ounces of copper sulphate, two to four ounces of hydrated lime and one-half gallon of water. The California Fruit Growers Exchange has found an emulsion of three to four and one-half gallons of Triumph oil, four to six gallons of lime-sulphur and calcium caseinate at the rate of one pound to each 100 gallons of diluted spray as satisfactory for citrus spraying under California conditions. Oregon adds two ounces of copper sulphate to produce a less viscous stock which is more easily poured. No doubt other formulae may have a special advantage for restricted areas.

The formulae of the two outstanding emulsions as shown above are as follows:

Original Boiled Lubricating Oil Emulsion

Oil	1 gallon
Potash Fish Oil Soap	1 pound
Water	½ gallon

Calcium Caseinate Cold Mixed Oil Emulsion

Oil	1 gallon
Calcium Caseinate	2 ounces[1]
Water	½ gallon

Question 2.—Have any results been obtained that would indicate what physical or chemical qualities an oil should possess to be of the greatest value for spraying purposes?

A moot question with many variable opinions. In general the oils within the limits specified in our last report are favored. These qualifications are:

Viscosity	90–250 seconds at 100°F. (Saybolt).
Volatility	Not over two per cent.
Specific Gravity	0.87 to 0.93 at 20°C.

[1]Amount of caseinate used and recommended varied from three-fourths to eight ounces. Insufficient data to draw final conclusions as to the optimum amount. Data seem to show that the minimum requirement or slightly more is preferable to an excess. Excess amounts of caseinate is said to increase the difficulties in making the stock emulsion and did not increase the efficiency of the spray.

While the unsaturated hydrocarbons in the oil seem to be desirable for the highest insecticidal effect, they are probably the most important factor in foliage injury. In oils where the unsaturated hydrocarbons have been removed the killing action is slower and therefore it is necessary to use an oil with considerable viscosity and comparatively low volatility.

There seems to be a difference of opinion as to the value of the heavier oils in comparison to the lighter oils, for the destruction of leaf-roller eggs. One investigator considers the paraffin base oils more effective against leaf-roller eggs than the asphalt base oils.

The qualities necessary for effectiveness are apparently not definitely recognized, nor is there a satisfactory understanding of the relative merit of different oils under different climatic conditions and for different insects.

Question 3.—What is the optimum amount of emulsifier to use? Should there be an excess of emulsifier or do you recommend the minimum requirement?

See answer to question 1. In general minimum requirements are best. Excess amounts (at least of caseinate) increase difficulties in emulsifying and may decrease insecticidal value.

Question 4.—Has any injury developed following the use of the lubricating oil emulsion on (a) deciduous trees and fruits?; (b) on citrus?; (c) if so, strengths and formulae which have proven harmful.

No injury by the 2, 3, or 4 per cent emulsion when properly used as a dormant spray for apple, pear and peach. Injury noted on peach when spraying was done during a snow storm and to apple when sprayed during very cold conditions, or where free oil occurred at end of tank load. Some injury was noted when 7 or 8 per cent emulsions were used, especially when the temperature fell below 28°F. the night following the spraying.

In general no injury to citrus with two per cent white oils. Apparently considerable injury where the ordinary boiled lubricating oil emulsion was used. In general oil sprays seem to interfere with the proper coloring of lemons.

When oil emulsions were used as summer sprays on deciduous fruits more or less injury was noted although in general a 2 per cent emulsion gave no injury so long as the temperature remained below 100°F. It is generally agreed that at present summer oil sprays should not be recommended for deciduous trees excepting in special emergency cases.

Question 5.—Is there any tendency toward the use of the so-called white oils?

Not used in deciduous tree sprays because unnecessary and too expensive.

Tendency toward their use for citrus trees and for summer sprays but cost is a limiting factor.

Question 6.—What do you consider the best emulsifier?

Soap is considered the best emulsifier by those who prefer the boiled emulsion and calcium caseinate by those using the cold mixed emulsion.

Question 7.—Have you any data regarding the effects of low temperature following spraying with oil emulsion?

In general no injury to deciduous trees with 2 to 4 per cent emulsions, even when spraying was followed with temperature as low as 10°F. There is a tendency to injury of citrus trees where cold follows spraying.

As a rule spraying when temperatures are below freezing is less effective against insects and increases the injury hazard. Such conditions should be avoided by growers.

Question 8.—What is your experience using the emulsion during the summer?

Injury to apple foliage and fruit with 2 per cent emulsion especially when temperature is 100°F. or higher. Usually no great injury otherwise but because of the possibilities of injury and difficulty in reaching insects when trees are in foliage should depend on dormant sprays and advise summer applications only in individual emergency cases. Usually severe injury to peach and prune foliage. White oil emulsions may be safe but at present insufficient data available.

Question 9.—Against what insects has the emulsion proven effective or ineffective?

San Jose scale.—Universally good control with a 2 or 3 per cent dormant oil emulsion, except in the northwest where a 4 per cent seems necessary.

Putnam, cottony maple, elm scurfy, and European elm scales.—Good control with the 2 to 3 per cent emulsion.

Oyster shell scale.—Several investigators report fairly good control with the usual dormant spray.

Greenhouse plant scales.—One per cent emulsion effective.

Aphididae.—Generally agreed that the usual dormant sprays ineffective. Usually fairly good control with delayed dormant spray; also later if aphids are exposed. On the other hand mature aphids proved rather difficult to destroy in some cases. A ½ to ¾ per cent emulsion with nicotine sulphate at the rate of 1–2000 was an efficient aphid control.

Blister mite.—Variable experience, some reporting effective control and others the opposite.

Red spiders (*Tetranychus telarius* and *Paratetranychus pilosus*).—Two to four per cent effective against eggs. One-half to two-thirds per cent emulsion with nicotine sulphate 1–2000 effective during summer.

White fly.—Effective control obtained in Florida.

Red bug (*Lygus mendax*).—One to two per cent emulsion effective against nymphs.

Fruit leaf-roller.—Seems to be generally effective against leaf-roller eggs at 6 to 8 per cent strength. At this strength, however, injury may result if proper precautions are not taken to spray only during favorable weather.

Red-banded leaf-roller (*Eulia velutinana*).—A one per cent emulsion gave a 100 per cent kill.

Onion maggot.—Results corroborate experiments of Compton and Flint.

Pear psylla.—In New York oil emulsions have not proven very effective against the eggs of the pear psylla although the nymphs on hatching succumbed to the oil residues on the bark of certain types of oil sprays. In Canada, on the other hand, one application of a 3 per cent oil emulsion applied in early April after the adults had emerged from their winter quarters, gave very clear-cut results in controlling the pear psylla.

Question 10. What is your experience using full strength Bordeaux in combination with the emulsion against plant diseases?; (a) effect on diseases?; (b) effect on insects?

Apparently does not appreciably change the effectiveness of the dormant 2 to 3 per cent oil spray.

Apparently Bordeaux is just as effective with the oil emulsion as when used alone. Several investigators report control of codling moth and scab as good in the combination spray as where the Bordeaux arsenate of lead spray alone was used. As good control of apple anthracnose canker with Bordeaux oil emulsion as with Bor-

deaux alone. In Florida the combination is satisfactory against citrus diseases. On account of scarcity of peach leaf curl the past few years, there is no definite data although the available information seems to favor the value of Bordeaux in the combination.

In conclusion, may we report the excellent progress made the past year and the tendency towards standardizing recommendations. No attempt has been made to suggest definite recommendations but it would seem desirable to make such recommendations for four areas,—Pacific Northwest, California Citrus Area, Florida, and the remainder of the United States. If this is done separate committees, composed of members from the respective areas, should formulate the recommendations. Investigators should be urged to conduct tests to corroborate or disprove the suggested standard recommendations.

Respectfully submitted,

W. W. YOTHERS
A. J. ACKERMAN
L. HASEMAN
J. J. DAVIS, *Chairman*
Committee

REPORT ON CALCIUM CYANIDE

In order to obtain information on the work done with calcium cyanide as an insecticide during 1925, a questionnaire was sent to Entomological workers in the Federal Bureau, and in all of the States.

Entomologists in 21 states report having done some work with this material, the results of the work herein reported being based on over 500 separate tests in an attempt to control some 38 different species of insects. As a result of these tests, a satisfactory control under certain conditions, has been obtained for the following species, and the material is being recommended for general use against the species: Newly hatched Grasshoppers, Agricultural Ant, Ants in lawns (various species), Aphids in greenhouses, adult leaf-rollers in greenhouses, Fleas, Bedbugs, Cockroaches, Clothes Moths under certain conditions, Chinch-bug, Indian Meal Moth, White Fly, Thrips, Sowbugs, Chrysanthemum Leaf Tyer, Tomato Aphis, Wireworms, and Grape Leafhoppers.

The material was tried against the following species without obtaining successful control: Mound Building Ant, Nematodes, White Fly, Symphilids, Greenhouse insects, Cabbage Aphis, Oriental Fruit Moth, Army Worm, Aphids under outdoor conditions, Cucumber Beetle, Spotted Cutworm, Apple Flea Weevil, Woolly Apple Aphis, White Grubs, Apple Curculio, European Corn Borer, Field Cricket, Grape Leafhopper, and Beet Leafhopper. The work with most of these insects is still in the experimental stage.

Several workers reported the material as giving the best results in the control of Wireworms of any insecticide yet used. These results were obtained by concentrating the Wireworms in plantings of drilled seed, and a week to two weeks later, drilling calcium cyanide inthe soil slightly below the seed rows where the Wireworms were feeding.

Certain species of Ant, particularly the Agricultural Ant of the west, *Pogonomyrmex occidentalis* has been successfully controlled in several instances.

Against animal pests, the material has given unsatisfactory results in two cases of a considerable number of tests for the control of the Prairie Dog. It has however

given the most excellent result in the control of rats and sparrows under conditions, found in several states. It is used as a dust blown into the burrows of the rats and against sparrows the material has been used as a dust blown into the vines or shrubs along the sides of houses where the sparrows are roosting. The results have not been satisfactory where the material was used in the open. In one state on sandy soil, the material gave poor control for groundhogs, but under most conditions, is an excellent material for killing these rodents.

Reports of tests on greenhouse insects, have, on the whole, shown very good control in tests on aphis, and a fair control on some other classes, especially adults of the leaf feeding insects. Strengths of ¼ ounce to 1,000 cubic feet gave a satisfactory kill of aphids in nearly all cases, with only slight injury in a few cases to the most susceptible plants. In some cases, this dosage has had to be repeated several times before a complete clean-up of the aphids was obtained.

The cost of treating with calcium cyanide under outdoor conditions has been prohibitive in a number of cases where it was necessary to use large amounts over considerable areas of ground. Nearly all experimenters report burning of plants unless a very low dosage of gas was used. Work by the Entomologists of one of the cyanide companies has shown that the term "calcium cyanide" is being used in altogether too broad a sense, and is causing considerable confusion as to the exact chemicals being employed. This work has also shown the need of greater care in identity of material used in experimental work, and of testing the effect of the residues remaining after treatment.

It is evident from the tests reported, that climatic conditions greatly effect the action of calcium cyanide on both insects and the plants. It is also evident from the replies received that there is very little correlation in the experimental work, and much of the work is being done in the way of casual experiments, and there is quite evidently a need of more cooperation and correlation between the entomologists in the various states, and those of the Federal government engaged in working with this material.

The American Cyanamid Company has, during the last year, compiled information obtained in this and other countries on many of the tests giving favorable results with calcium cyanide, and this compilation of experimental work is of much value to anyone working experimentally with this material.

W. P. FLINT
E. N. CORY
J. W. MCCOLLOCH
Committee

Scientific Notes

Notes on *Hylobius pales* Boh. and *Pissodes strobi* Peck as Nursery Pests. During the nursery inspection in Pennsylvania in 1923 it was noticed that the pines, spruces and firs in one nursery were badly scored and whitened with resin but a careful search failed to reveal the cause of the injury.

On May 29, 1924, I beat the foliage of injured pines and captured several large weevils identified as *Hylobius pales* Boh. by Dr. T. L. Guyton.

On the 8th, 13th, and 15th of April, 1925, I pulled up a number of dead Cembra pines, Mugho pines and some spruces and examined the roots to find out what had killed them during the winter. On peeling off the bark from the roots I found numer-

ous grubs of various sizes of both Pales weevil and the white pine weevil and also a few unemerged adults of each but no pupae. The bark infested with these grubs showed neither frass nor exudation of resin so that their presence was not suspected until the bark was cut into.

On May 5th similar scoring and dead trees were noticed in another nursery and an examination of a freshly killed Mugho pine showed the presence of a number of grubs of the white pine weevil.

On May 26th Mr. Floyd Smith beat an adult Pales weevil from a scored pine in the nursery where the injury was first noticed and I found grubs of *Pissodes strobi* Peck and of *Hylobius pales* Boh. in the roots of pines and spruces which had died since the previous inspection. Tiny newly hatched grubs were found in the stumps of some Scotch pines which had been cut recently.

On July 14th an adult white pine weevil was beaten from a badly scored Mugho pine in another nursery and the work of the grubs was seen in the roots of recently killed trees.

On August 4th a dead *Pinus ponderosa* was found in the nursery where the trouble was first noticed and I found 15 grubs and 4 pupae, some of which were of Pales weevil and some of the white pine weevil, in the roots. The stem was about 3 inches thick.

On Sept. 30th an adult white pine weevil was beaten from Mugho pines heavily scored with feeding by adult weevils in another nursery.

I do not know of any way to detect the presence of the grubs in the roots of living trees though the presence of adults is very noticeable due to the scored stems.

ARTHUR B. WELLS

The Corn Ear-Worm on Tomato. The corn ear worm, *Alabama argillacea* Hubn., is the worst tomato pest in Tennessee. Crosby and Leonard, in their Manual of Vegetable Garden Insects, recommend spraying and the use of corn as a trap crop for control measures. A careful search of the literature revealed few data as to just how useful corn might be in trapping the worm. With the hope that a trap crop would be worth while, extensive experiments were begun in 1923 with various systems of interplanting. Much to our surprise, those plots where corn was planted among the tomatoes showed most injury. Good protection, however, was obtained by spraying with lead arsenate at the rate of 1 pound to 50 gallons of water.

More detailed results will be found in bulletin 133 of the Tennessee Experiment Station. The results are summarized as follows:

1. Three years' work with corn as a trap crop planted among tomatoes did not give adequate protection against the corn ear worm in tomatoes.
2. On June 21, 1924, a count showed 66 wormy tomatoes in the plot where corn alternated with tomatoes; 19 in the check plot; and $5^{8}/_{10}$ in the sprayed plot.
3. Good protection was obtained by spraying with lead arsenate.

S. MARCOVITCH.

The Chinese Cotton Geometrid (*Boarmia* sp.) and its Possible Introduction (*Lepid.*). This is a native Chinese species which has become, since 1918, a serious pest of cotton in China.

During 1919 and 1920 the cotton crop in the coastwise districts was damaged in excess of sixty per cent by this undetermined species of *Boarmia*. The government of the province of Kiangsu in 1922 organized an Entomological Station for the study of this pest in which the writer was employed.

On August 29, 1925 the writer sailed for the United States on board the steamship President McKinley, to begin graduate work at the University of Illinois. In mid-ocean on September 10, five days before arriving at Seattle, the writer found, much to his surprise, an adult female moth of this species resting on the deck of the ship. It was captured and upon examination, found to contain 244 eggs.

This capture of this moth on shipboard emphasizes the danger of the introduction of such pests and shows a method by which they may gain entrance to this country despite the efforts of quarantine officials.

FO CHING WOO

MEETING OF EXTENSION ENTOMOLOGISTS AND THOSE INTERESTED IN THE INSECT PEST SURVEY

On Tuesday, December 29th, the Extension Entomologists and those interested in the Insect Pest Survey met in the Venetian Room at the Hotel Baltimore. President W. P. Flint called the meeting to order and introduced Dr. J. A. Hyslop who gave a short report on the Insect Pest Survey and outlined the future policy of this work. Professor A. L. Ford, Extension Entomologist of the Extension Service, Brookings, S. Dak., then gave an interesting report of his Household Insect Control project. He had on display his demonstration kit which is made up for use of the local leaders who take the project to the local people in the school districts of the county. Professor E. G. Kelly, Kansas State Agricultural College, Extension Service, gave an interesting report of the advantage taken by the Kansas State Agricultural College, Extension Service of the Kansas Wheat Girl. In this connection, they developed what they termed, the Kansas Wheat Train which made a trip to the main centers in the wheat districts of the state. The control of insects and plant diseases and the cultural methods for the most satisfactory wheat yield were taken up at each of these meetings, after the populace had had an opportunity to see the Kansas Wheat Girl. This young lady had been selected thru newspaper contests as a Kansas representative who carried to Pres. Coolidge a sample of Kansas wheat, and instigated the slogan which has afterwards covered the state "Kansas Raises the Best Wheat in the World." Prof. Kelly reported that as a result of the people reached by this method, that the cooperation of the wheat growers in controlling the Hessian Fly infestation had been the most satisfactory of any year.

Professor W. E. Hinds, Louisiana State Agricultural College, Baton Rouge, Louisiana, gave a very interesting report of the development of aeroplane dusting for the control of the cotton boll weevil. He pointed out in detail the organization which had been made in Louisiana of the Extension Service, workers in Entomology, and the commercial concern which handles the plants and did the actual dusting. Professor Hinds reported that this method of control for insects by the use of an especially adapted aeroplane gave promise of very satisfactory results and reported that the farmers of Louisiana were well pleased with the work which had been done with them this past season. In this connection Dr. A. W. Morrell of California reported that he intended to investigate aeroplane dusting in some of his districts in Mexico for the control of insects which are bothering tomato plantings. Professor Geo. M. List, Colorado State Agricultural College, Fort Collins, Colorado, reported the status of Extension work in Entomology in Colorado. Professor List pointed out that the varying conditions on account of the wide ranges of altitude in Colorado made state-

wide Extension Service work difficult and that most of the work was being most satisfactorily handled by stationing men in small districts during the period of insect activity.

At the close of the meeting, Professor H. E. Hodgkiss, State College, Pa., was elected president of the Extension Entomologist and Insect Pest Survey sections. Professor P. D. Sanders, College Park, Md., was elected Secretary. On motion of Dr. J. J. Davis, Purdue University, Lafayette, Ind. the secretary was requested to hand to the general resolution Committee of the American Association of Economic Entomologists a memorandum recommending to this committee that they consider a resolution asking the United States Department of Agriculture to give more assistance to the Insect Pest Survey.

FRED D. BUTCHER,
Secretary

ANNUAL MEETING OF NORTH CENTRAL STATE ENTOMOLOGISTS

The North Central State Entomologists held their annual meeting at the New Agricultural Building, University of Illinois, Urbana, Illinois, on March 4–5th. Following the custom of previous meetings no formal papers or reports were presented. Instead various individuals, particularly in touch with certain lines of research, were called upon to open the discussion concerning topics of special and timely importance to the states represented at the meeting. Immediately following the introductory speakers the topic was opened for general discussion. The topics discussed were fruit tree insects, truck insects, shade tree insects, field crop insects, insects affecting live stock, research projects and plans, recent developments in insecticides and the value of repellents in insect control. Special attention was devoted to the present European corn borer and Mexican bean beetle situations. A general discussion concerning the content of beginning courses in entomology, the advisability of such courses being required, and entomological publicity marked the close of the business sessions. A dinner for entomologists was held the evening of March 4th. J. W. McColloch was elected Chairman and T. H. Frison Secretary of the meeting. It was decided that the meeting for next year would be held at Madison, Wisconsin.

The following were present at the meeting: J. S. Houser, T. H. Parks, C. R. Cutright, R. Faxon, D. M. De Long, C. H. Kennedy and R. C. Osburn, Ohio; F. N. Wallace, H. F. Dietz, J. J. Davis and C. R. Cleveland, Indiana; J. W. McColloch and H. B. Hungerford, Kansas; L. Haseman, Missouri; A. G. Ruggles, Minnesota; C. L. Fluke, S. B. Fracker and E. L. Chambers, Wisconsin; M. H. Swenk, Nebraska; R. H. Pettit, Michigan; P. H. Lockhart, H. T. Seifert, F. G. Anderson, V. E. Shelford, W. V. Balduf, E. E. Wehr, R. M. De Coursey, A. O. Plummer, W. P. Hayes, K. F. Auden, L. L. English, G. E. King, A. E. Miller, J. C. Frankenfeld, M. R. Smith, S. C. Chandler, C. C. Compton, J. H. Bigger, V. G. Milum, C. H. Fernald, F. H. Benjamin, P. A. Glenn, T. H. Frison, C. L. Metcalf, R. D. Glasgow, S. A. Forbes and W. P. Flint, Illinois; W. B. Cartwright, and W. B. Noble, La Fayette, Indiana; C. N. Ainslie, Souix City, Iowa, A. F. Satterthwait, Webster Groves, Missouri, B. A. Porter, Vincennes, Indiana, L. H. Worthley, Arlington, Massachusetts, W. H. Larrimer, Washington, D. C., J. E. Dudley, Madison, Wisconsin, N. F. Howard, Columbus, Ohio and J. R. Horton, Wichita, Kansas, U. S. Bureau of Entomology; A. G. Dustan, Dominion of Canada.

PACIFIC SLOPE BRANCH MEETING

The next regular meeting of the Pacific Slope Branch, American Association of Economic Entomologists, will be held in connection with the Pacific Division, A.A.A.S., at Mills College, Oakland, California, June 16–19, 1926. The preliminary program is as follows: Thursday, June 17: At Berkeley, Room 113, Agriculture Hall, University of California, 9:30 A. M., Business meeting; 10:15, Address by Chairman; 10:30, Reading of Papers; 2:00 P. M., Symposium under the joint auspices of the Pacific Slope Branch, and the Pacific Slope Entomological Society. Topic: The Fundamental Value of Life History Data. Friday, June 18: At Mills College, Oakland, California, 9:30 A. M., Symposium, Petroleum Oil Sprays in Insect Control; 1:30 P. M., Reading of Papers; 3:00, Final Business meeting; 3:30, Third Annual Pacific Coast Championship Ball Game, Federal vs. State Entomologists; 6:30, Entomologist's Dinner. Saturday, June 19: Excursion to Muir Woods. Titles of papers to be presented should be sent to the Secretary, Mr. Roy E. Campbell, Box 297, Alhambra, California, as soon as possible, so the complete list can be made out and printed in the final program, at the latest by May 14. Meals and lodging will be provided at Mills College, at the rate of three dollars per day; rooms without meals, one dollar twenty-five cents per day. For reservations, write Prof. Earle G. Linsley, Director, Chabot Observatory, R. F. D. No. 1, Oakland, California.

NOTICE PERTAINING TO REGULATION REGARDING DELINQUENT MEMBERS

At the last annual meeting the Committee on Membership brought in the following recommendations regarding delinquent members: "After January 1, 1926, it shall be the duty of the Secretary to notify all members who are in arrears for one year that unless full payment is made within the current year, their names will be dropped from the rolls.

"Members dropped for this reason must accompany their application for re-instatement with twelve dollars ($12.00) which will cover back indebtedness and cost of dues and JOURNAL for one year in advance. This payment shall entitle the applicant to be furnished with such copies of the JOURNAL for the years concerned, as the Secretary's record indicates have not been previously supplied. All such applications for re-instatement must be referred to the Membership Committee for consideration and reported at the annual meeting."

These regulations were discussed at length at the meeting, especially the last section which calls for $12.00 to be paid as a re-instatement fee. It was finally voted that the recommendations with reference to this re-instatement fee be referred to the Executive Committee with power to act after consulting an attorney to find out whether the Association is legally correct in the matter.

An attorney has been consulted who finds that there is no conflict with the postal regulations. The Executive Committee has been informed of the findings of the attorney and have been polled and a majority have voted in favor of the regulation proposed by the Committee on Membership.

In accordance with the vote of the Executive Committee, notices will be sent to all delinquent members informing them of their back indebtedness to the Association.

C. W. COLLINS,
Secretary

Melrose Highlands, Mass.
April 9, 1926.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1926

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $2.50 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

One hundred separates or reprints at $1.50 per page or plate. Additional hundreds or less, 4 pages or less, $1.00; 5–8 pages, $1.50; 9–12 pages, $1.75; 13–16 pages, $2.00; 17–24 pages, $3.00; 25–32 pages, $4.00. Covers suitably printed on first page only, 100 copies, or less, $4.50; additional hundreds, or less, $1.75. Plates inserted, $1.75 per hundred, or less. Folio reprints, the uncut folded pages (50 only), sixteen page signature, or less, $3.00. A discount of 10 per cent and 20 per cent from the above prices will be allowed on orders of 500 and 1000 reprints respectively.

The symposium on parasitism gives the broad outlines of one of the more fundamental developments in economic entomology. It is the utilization of natural agents in the reestablishment of the "balance of nature," an adjustment continually being disturbed by man's activities. Biological control is basic and capable of much greater development. This latter can be accomplished in safety only when all the factors involved are well understood and mastery of such a complex subject is the work of many years—probably several generations. These obvious difficulties should not be allowed to hinder a most promising line of work, one which can be pressed very successfully by federal agencies.

The somewhat extended discussion on the legal aspects of state quarantine regulations to interstate commerce raises some very important questions. A state has the right to protect its material interests from dangers within and without, provided it can be shown that a menace of sufficient magnitude exists. It is doubtful if this power can be extended to protect other states, except as there may be a measure of local protection. Restrictions upon interstate commerce are the peculiar province of the federal government. The numerous quarantines in this country have brought about a most complex and in some respects unfortunate situation. There should be a comprehensive study of the entire problem in an effort to simplify without material sacrifice in efficiency.

Endowment of research is in the air and is the logical method of producing the best results in the long run, though we would cast no reflection on the multitudinous and most excellent research projects

now conducted by various governmental and other agencies. A very large proportion of the present investigations in entomology are limited and to a certain extent dominated by material or economic considerations and not a few are seriously hampered so far as a comprehensive program is concerned, by the uncertainty as to the future inseparable from dependence upon annual or biennial appropriations. There should be several independent research foundations concerned chiefly with the fundamentals in economic or applied entomology, organized in such a manner as to afford the fullest possible liberty to the investigators in following up promising or even unpromising leads. We are expending enormous sums annually in the study of various phases of what appear to be immediately practical problems and have a nation-wide system for checking or preventing the spread of injurious insects and plant diseases. Much of this is undoubtedly wise, some is presumably of little value because fundamentals have been ignored—possibly remaining to be discovered. These considerations lead us to call special attention to Dr. Shelford's suggestions in this issue relative to endowment for research in entomology. He instances one phase. We are suggesting a more comprehensive program and the endowment of several foundations so located and organized as to fully meet the needs of a rapidly growing branch of biological work.

Obituary

JOHN ANDERSON McLEMORE AND WILLIAM MALCOLM MINGEE

John Anderson McLemore and William Malcolm Mingee, Junior Entomologists, employed by the Division of Truck Crop Insect Investigations, Sweet Potato Weevil Eradication, and stationed at Picayune, Pearl River County, Mississippi, were foully murdered on February 18, 1926. At first it was thought that they had been mistaken for revenue officers, but later evidence indicated that the motive for the diabolical deed was robbery. The murderer was promptly apprehended and given a speedy trial, receiving a sentence of life imprisonment. The plea of insanity introduced by the defense no doubt influenced some of the jurors in deciding against the death penalty.

Messrs. McLemore and Mingee, graduates of the A. & M. College of Mississippi, had been connected with The Bureau of Entomology several years, Mr. Mingee coming into the service in 1919 and Mr.

McLemore in 1921. Both were married, each being survived by a wife and two small children. Both men were held in the highest esteem by the citizens of Picayune where they resided. Their untimely deaths are greatly mourned by friends and co-workers in the Bureau and the Mississippi State Plant Board who fully recognize their sterling qualities as men, and their faithful service in the work in which they were engaged. This double tragedy is probably the greatest of its kind that has ever befallen the Bureau of Entomology.

K. L. COCKERHAM.

DOUGLAS BARZILLAE YOUNG

DOUGLAS BARZILLAE YOUNG, born March 3, 1860 at Cassville, N. Y., died suddenly at Albany, N. Y., April 5, 1926. He was one of the older members of the Association, one of the earliest subscribers to Entomological News and known to a number in the nineties as an exceptional collector of Coleoptera and Microlepidoptera; later he collected extensively in the smaller Diptera. His captures of gall midges about 1905 supplied the material for our early studies of the Itonididae. He was appointed on the New York State Museum staff in January 1902, holding the position of Assistant State Entomologist for nearly twenty-five years. Mr. Young's inclinations were toward collecting, faunal and systematic studies. He was the author of several local lists and as curator of insects, he made numerous valuable additions to the State collections and much of the excellent arrangement and classification of the myriad additions were due to his labors. A large part of the installation of the attractive insect exhibit was his work. In addition, he kept in close touch with the economic work of the office and was exceptionally efficient in rearing insects. Although not a college man, he was a student throughout life and constantly looking up various problems. His high ideals endeared him to all his associates.

E. P. FELT.

Current Notes

Mr. M. McPhail of Clemson Agricultural College, Clemson, South Carolina, is taking graduate work in entomology at Iowa State College.

Dr. L. O. Howard addressed the Science Club of the Kansas State Agricultural College on January 4, on "The Biological Control of Insects."

Professor J. S. Houser has recently been officially appointed entomologist of the Agricultural Experiment Station, Wooster, Ohio, to succeed the late Professor H. A. Gossard.

Mr. H. E. Goold of Sussex, New Brunswick, for many years Superintendent in charge of the Fumigation Station at St. John, N. B., died February 9.

Professor John J. Davis of Purdue University on January 26 gave an address before the Illinois State Florists' Association on "Some Greenhouse Insect Problems."

Professor J. D. Hood, of Rochester University, spent the Christmas vacation week at the Division of Insects, U. S. National Museum, studying the Museum collection of Thysanoptera.

Mr. F. S. Chamberlin, Bureau of Entomology, Quincy, Fla., attented the South Georgia Tobacco conference at Tifton, Ga., January 23, where tobacco insect control was discussed.

Mr. Morgan Hebard of the Philadelphia Academy of Natural Sciences, called at the Division of Insects, U. S. National Museum, January 30, to consult with Mr. Caudell.

Mr. L. B. Smith, in charge of the Japanese Beetle Laboratory, Riverton, N. J., addressed a meeting of the Eastern Nurserymen's Association held at Trenton, N. J., January 14.

Mr. H. L. Viereck, of the Entomological Branch, Canadian Department of Agriculture, spent January 30, consulting with Mr. Gahan and Mr. Cushman at the U. S. National Museum.

Mr. J. G. Meyers, Entomologist, Wellington, N. Z., and Dr. V. V. Nikolsky, Chief of the Entomological Section, Moscow Tropical Institute, Moscow, Russia, have recently visited the United States.

Dr. Vernon L. Kellogg, retiring president of the Washington Academy of Sciences, addressed the 205th meeting of the Academy, February 18, on "Some Things Science Doesn't Know."

The following appointments to the Entomological Branch, Canadian Department of Agriculture, have recently been announced: M. T. Rankin, Ottawa; Miss Emily Turner, Stenographer, Ottawa; Mr. E. P. Venables, Junior Entomologist, Vernon.

Mr. Norman Criddle, Treesbank Laboratory, Entomological Branch, gave a lecture on "The Wild Life of Manitoba" before the Quebec Society for the Protection of Birds, at Montreal, February 8.

According to *Science*, Dr. E. D. Ball, on January 20, addressed the recently organized Sigma Xi Club of the University of Florida on "The Training and Compensation of the Scientist."

Mr. G. H. H. Tate, of New York, was at the U. S. National Museum for several days of the last week in December, making photographs of certain moths of the subfamily Hadeninae.

Mr. Harold S. Peters, a postgraduate student of the Ohio State University, spent several days of his Christmas vacation at the U. S. National Museum, identifying his large collection of Ohio Mallophaga.

Mr. George A. Ehrman, a collector of Lepidoptera and Coleoptera and a contributor to American entomological journals, died at his home in Pittsburgh, Pa. January 30, in the 64th year of his age.

Messrs. C. C. Hill and H. D. Smith, of the Carlisle, Pa., laboratory of the Bureau of Entomology, attended the meeting and dinner of the Entomological Society of Pennsylvania, held in Harrisburg, January 18.

According to *Science*, Mr. Ray T. Webber of the Gipsy Moth Laboratory of the Bureau of Entomology left for Europe recently, to secure parasites for the gipsy moth and other introduced moths.

On January 20 and 21, exhibits of work against the European corn borer and the gipsy moth were displayed at the annual meeting of the Massachusetts Tree Wardens' and Foresters' Association at Boston.

Mr. H. N. Bartley, in charge of the Silver Creek, N. Y., corn borer laboratory, visited Arlington, Mass., on January 11, for consultation regarding the work in western New York for the season of 1926.

Mr. John E. Graf, in charge of the Truck Crop Insect Investigations of the Bureau of Entomology has recently been appointed a member of the Federal Horticultural Board *vice* Dr. W. D. Hunter, deceased.

Dr. H. C. Huckett, of the New York (Geneva) Experiment Station, stationed at Riverhead, L. I., spent a few weeks in January in the Division of Insects, U. S. National Museum, studying Diptera belonging to the family Anthomyiidae.

On January 20, at Boston, Mr. A. F. Burgess addressed a meeting of the Massachusetts Moth Superintendents and the Massachusetts Tree Wardens' and Foresters' Association on "The Present Gipsy Moth and Brown-tail Moth Situation."

Mr. L. E. Dills, a graduate assistant in entomology, Iowa State College, Ames, Iowa, has accepted a position as assistant entomologist in the University of West Virginia. Mr. Dills will begin work at Morgantown, March 15.

Mr. B. R. Leach of the Japanese Beetle Laboratory, Bureau of Entomology, attended the meeting of the Greens Section, U. S. Golf Association, held in Chicago on January 8, and spoke on "A Method of Grub-proofing Turf."

Dr. H. L. Dozier, State Entomologist of Delaware, interested in the Anaphoidea breeding work being conducted by A. F. Satterthwait, was a visitor at the Webster Groves, Mo., laboratory of the Bureau of Entomology on January 3.

Dr. J. C. Crawford, of the North Carolina Department of Agriculture, recently spent about a week in the Division of Insects, U. S. National Museum, examining types of bees, consulting with various specialists, and arranging for exchanges of material.

Resignations in the Bureau of Entomology have been announced as follows: S. H. Rountree, Florida, to enter commercial fields; L. H. Curet, Alabama; Torbet Slack, Collaborator, Louisiana; Raymond C. Shannon to accept a position with the Government of Argentina.

Professor Charles V. Piper, for 22 years agrostologist of the U. S. Department of Agriculture, and formerly professor of entomology, zoology and botany at the Washington State College, Pullman, Wash., died at Washington, D. C., February 11, aged 58 years.

Dr. R. J. Tillyard, Entomologist and Chief of Biological Department at the Cawthron Institute of Scientific Research, Nelson, New Zealand, is making a visit to the United States and will give a lecture at Yale University the latter part of April.

According to *Science*, Professor Herbert Osborn, of the Ohio State University, gave an address on "Early Workers in American Entomology" before the Sigma Xi Club and the Entomological Society of the University of Florida on the evening of March 1.

Mr. T. R. Chamberlain, of the U. S. Entomological Laboratory, Salt Lake City, Utah, spent the first two weeks of January in Washington, working on the collection of parasitic Hymenoptera in the National Museum and consulting with Messrs. A. B. Gahan and R. A. Cushman.

Mr. James B. Cronin of the Japanese Beetle Laboratory, Riverton, N. J., spent about three weeks in January in the Division of Insects, U. S. National Museum, studying the collection of Tiphia and other scoliids and consulting with specialists in the taxonomy of these groups.

Mr. C. E. Petch of the Hemmingford, Que., Laboratory, Entomological Branch, presented two papers, "The Adaptations of Insects to Life" and "Some Wonderful Things about Insects" before members of the Y. M. C. A. at Sherbrooke, December 17–18, and attended a meeting of the Quebec Pomological Society at Montreal, January 14.

Mr. R. P. Gorham, returning to Fredericton from Ottawa on December 7, visited Macdonald College, Que., to consult entomological literature in the library, and to meet members of the staff. He reports that the insecticide-mixing and garage building, attached to the Fredericton laboratory, was completed late in December.

Mr. Rodney Cecil, of the Bureau of Entomology, U. S. Department of Agriculture, who is stationed at the Geneva Experiment Station, Geneva, N. Y., has secured a leave of absence for three months in order to complete his work for a Master's degree at Iowa State College, Ames, Iowa.

Recent appointments in the Bureau of Entomology have been announced as follows: J. E. Eckert, North Carolina State College, to become associate apiculturist; Donald L. Parker, Massachusetts Agricultural College, and Samuel F. Potts, Mississippi Agricultural and Mechanical College, Junior entomologists, Gipsy Moth Investigations; F. P. Amsler, field assistant, Grand Bay, Ala.

Messrs. A. F. Burgess, S. S. Crossman, and H. L. Blaisdell attended the New England Forestry Congress held at Springfield, Mass., on December 10 and 11, 1925. A conference was held with L. S. McLaine, Chief of the Division of Foreign Insect Suppression, Ottawa, Canada, and H. L. McIntyre, of the New York Conservation Commission.

At an institute for Connecticut tree workers, held at the Agricultural Experiment Station, New Haven, January 26, illustrated lectures were given by Mr. William Middleton of the Bureau of Entomology on "Some Insects Attacking Shade Trees" and by Dr. Philip Garman of the Connecticut Station on "Mites and Their Injury to Trees."

The Department of Zoology and Entomology of the Alabama Polytechnic Institute had the pleasure of entertaining Dr. Herbert Osborn of Ohio State University during the week beginning March 7th. Dr. Osborn gave a formal lecture on "Early History of Entomology" before a joint meeting of the Agriculture Club and Gamma Sigma Delta, the honor society of Agriculture. There were over a hundred in attendance at this meeting.

Mr. H. Bennett Johnston of Wellcome Tropical Research Laboratory, Khartum and Assistant Entomologist of the Sudan Government, has been in the United States and visited the Gipsy Moth Parasite Laboratory at Melrose Highlands, Mass., the Japanese Beetle Laboratory at Riverton, N. J., the Tallulah, La., Laboratory, and other field stations of the Bureau.

Mr. W. Downes of the Victoria, B. C., Laboratory, Entomological Branch, attended the annual meeting of the Western Washington Horticulturists at Bellingham, December 2–4, where he gave an account of the control of the strawberry root weevil in British Columbia. Mr. Downes also gave an address on weevil control at the annual meeting of the Saanich Fruit Growers' Association, on December 29.

Mr. R. Glendenning of the Agassiz, B. C., Laboratory, Entomological Branch, visited Vancouver December 16–19, in connection with the control of *Lecanium capreae* and the satin moth, and to attend a meeting of the Advisory Board of the Entomological Society of British Columbia. On December 14, Mr. Glendenning gave a talk on the hop aphis to children of the Agassiz Public School.

Messrs. Ralph Hopping, Entomological Branch, and forest entomologist Evenden, of Idaho, were present at the annual meeting of the Western Forestry and Conservation Association at Victoria, B. C., December 7–10. The general attitude of the meeting toward brush disposal was most satisfactory from the entomological standpoint. Some form of piling and burning was considered a much better method of brush disposal than broadcast burning.

The following transfers in the Bureau of Entomology have recently been announced: A. J. Chapman, Tallulah, La., to Tucson, Ariz.; K. P. Ewing and A. C. Johnson from Federal Horticultural Board to the Bureau of Entomology; Rodney Cecil, Geneva, N. Y., to Columbus, Ohio; H. E. Wallace and J. U. Gilmore, who were transferred to the Bureau of Entomology for pink boll worm scouting, have returned to their respective stations at Mound, La., and Clarksville, Tenn.

On the invitation of the Wenatchee (Washington) Horticultural Association, Dr. Ralph H. Smith of Stanford University delivered a series of six addresses on codling moth control in the apple district of central Washington the last week of January. Dr. Smith is preparing a number of articles on his research with the codling moth, which are being printed in Better Fruit, published at Portland, Ore. The first article appeared in the December number.

Professor Kota Monzen, of the Imperial College of Agriculture and Forestry at Morioka, Japan, spent several days during the winter studying aphids with Doctor Baker and Doctor Mason of the Bureau of Entomology. Professor Monzen is especially interested in the genus Melaphis. This genus is principally an oriental one, and includes the species which forms the Chinese gall of commerce. He also visited the U. S. National Museum and studied some types of gall-making Cynipids.

The Third Annual Conference of Indiana Entomologists met at Terre Haute, Indiana, December 10, in connection with the meetings of the State Academy of Science. Those present included R. Burkhart, J. J. Davis, H. F. Dietz, H. E. Enders, S. R. Esten, L. L. Heidom, A. C. Kinsey, B. A. Porter, O. J. Price, C. J. Quick, R. F. Sazama, B. H. Smith, and Ralph Voris. J. J. Davis acted as chairman of the meeting. The next annual meeting will be held in December 1926 at Muncie, Indiana, and Mr. H. F. Dietz was selected as chairman of the next meeting.

A meeting of the Advisory Committee on Japanese Beetle Control was held at Philadelphia on January 26, for the purpose of discussing matters of policy and future plans on Japanese beetle control work. Those present were Dr. A. L. Quaintance, Bureau of Entomology, Washington, D. C., Hon. F. P. Willits, Secretary of Agriculture, Harrisburg, Pa., Hon. W. B. Duryee, Secretary of Agriculture, Trenton, N. J., Harry B. Weiss, Chief of Bureau of Statistics and Inspection, Trenton, Dr. T. J. Headlee, State Entomologist, New Brunswick, N. J. C. H. Hadley, Director, Bureau of Plant Industry, Harrisburg, Pa., L. B. Smith and C. W. Stockwell, Japanese Beetle Laboratory, Riverton, N. J.

Dr. F. C. Craighead of the Bureau of Entomology attended a meeting of the Appalachian Forest Research Council at Richmond, Va., on January 5. This Council is composed of a group of representative men from educational institutions, state organizations, and lumbering concerns interested in forestry. They review the work of the forest station and suggest proposals for the lines of study that will be of particular benefit to the development of good forest practices. A resolution was passed and transmitted to Dr. Howard expressing their appreciation of the assistance rendered by the Bureau of Entomology during the past season.

In December a serious outbreak of the dermestid, *Anthrenus seminiveus* Casey, was brought to the attention of the Bureau of Entomology. In 1916 Colonel Casey described this insect as new, from specimens collected in an apartment hotel on Connecticut Avenue, Washington. Since the original description appeared this species has never been recorded except on two occasions late in 1925. In one instance the insect had destroyed the brushes in a leather case containing a shoe blackening outfit and in another it had attacked the curled hair stuffing of a piece of upholstered furniture. One of these instances of damage occurred in the building which was occupied by Colonel Casey; the other in a building about half a mile distant.

Meetings of the Entomologists Group of the Professional Institute were held in Ottawa on January 20 and February 10. At the former meeting two papers were read prepared by Mr. R. P. Gorham, entitled "The Oldest Road in New Brunswick and How Two Travellers Sought it one Winter Morning" and "A Snowshoe Tramp over the Mamozekel Trail;" and at the latter meeting Mr. Ralph Hopping read a paper on "The Forest Crop of British Columbia, and Its Enemies." The latter paper was followed by an interesting account by Dr. J. M. Swaine of the valuable results obtained by a visit made with Mr. Hopping to the bark-beetle devastated forest area in California last summer.*

Mr. H. G. Crawford of the Entomological Branch, gave an address on "How Insects Live," to children at the Victoria Museum, on December 12, and a lecture on "Insect Pressure on Civilization" to adults, at the same place on December 16. Mr. Crawford visited western Ontario, particularly the Chatham district, in mid-January, where, assisted by Mr. C. S. Thompson, of the Division of Foreign Pests Suppression, he investigated the part played by crows in controlling the European corn borer. It was estimated in the areas examined that these birds had been responsible for the destruction of fully 25 per cent of overwintering borers. Mr. Crawford visited Columbus, Ohio, February 1–5, where he attended the 14th Annual Farmers Week gathering and delivered three addresses on different phases of corn borer control.

Mr. W. A. Ross, Vineland Laboratory, Entomological Branch, in company with Mr. L. F. Strickland, of the New York Bureau of Plant Industry, visited orchards infested by the cottony peach scale, in Niagara County, N. Y., on December 18. This insect, which is a serious pest of peaches, is occurring in outbreak form in orchards along the Lake Ontario shore, extending as far west as the Canadian border. On December 10, Mr. Ross led a discussion on orchard spraying at a Fruit-growers Short Course Meeting, at Stoney Creek. Mr. Ross also attended the annual meeting of the Canadian section of the American Society of Phytopathologists, held at St. Catharines, December 21–22; the annual meeting of the New York State Horticultural Society at Rochester January 13–16; Niagara Peninsula Fruit Growers' Association, January 21.

A meeting of gipsy moth men was held at the American Museum of Natural History New York City, March 30 and 31. About 75 were present and some of the speakers were: C. H. Hadley, Director, Bureau of Plant Industry, Harrisburg, Pa.; Dr. T. J. Headlee, State Entomologist, New Brunswick, N. J.; Dr. E. P. Felt, State Entomologist, and H. L. McIntyre, Supervisor, Gipsy Moth Control, Albany, N. Y.; A. F. Burgess and C. W. Collins, Federal Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass.; L. S. McLaine and W. N. Keenan, Entomological Branch, Ottawa, Canada; Dr. W. E. Britton, State Entomologist, New Haven, Conn.; Mr. Hausmann of the Division of Employment, New York State Department of Labor. Albany, N. Y.

Apicultural Notes

Doctor Vincens, who last fall resigned as Director of the Station of Apicultural Research at Montpelier, France, died in Algiers shortly afterward.

Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, took part in the Beekeeping Short Course held at Ames, Iowa, in February.

Announcement has been made that the Archiv für Bienenkunde, founded by Doctor Armbruster of Germany in 1921 and discontinued in 1924, will appear again during the present year.

Mr. C. S. Rude, Chief Apiary Inspector of Texas, has resigned to become extension entomologist at the Oklahoma A. &. M. College. His successor in Texas is Mr. S. E. McGregor, Jr.

Mr. G. H. Cale, Assistant Editor of the American Bee Journal, visited the Bee Culture Laboratory of the Bureau of Entomology in January. He was formerly connected with this Laboratory.

Mr. W. J. Nolan of the Bee Culture Laboratory of the Bureau of Entomology was one of the speakers at the annual meeting of the Pennsylvania State Beekeepers' Association held at Harrisburg.

Mr. W. E. Dunham, who has been taking graduate work in Apiculture at Cornell University, has been appointed to teach this subject at Ohio State University, beginning with the spring term of the present year.

Mr. M. A. Perret-Maisonneuve has been chosen Secretary of the Société Centrale d'Apiculture of France. A third edition of his book "Apiculture Intensive et Elevage des Reines" was to appear in March of this year.

Mr. Morley Pettit of Georgetown, Ontario, is acting as manager of the Stover Apiaries of Georgia for the package shipping season of 1926 and making a study of the package bee business from the producer's standpoint.

Mr. J. A. Munro, graduate student in apiculture and entomology at Cornell University has been appointed, effective April 1, to fill the place vacated by Dr. R. L. Webster at the Agricultural College and Experiment Station at Fargo, N. D.

The species of Amoeba, which in Europe has been found to cause damage by becoming encysted in the Malphigian tubules of the honeybee, has been named *Vahlkampfia* (*Malpighamoeba*) *mellifica*. This organism was described first in 1916 by Doctor Maassen of Germany.

During January and February, Mr. Jas. I. Hambleton, of the Bee Culture Laboratory of the Bureau of Entomology, participated in beekeepers' meetings in Iowa, Nebraska, Wyoming, Montana, Washington, Oregon, California, Utah, South Dakota and North Dakota, as well as in the Short Course held by Purdue University.

Dr. A. P. Sturtevant, Messrs. E. L. Sechrist, J. E. Eckert, and W. J. Nolan, of the Bee Culture Laboratory of the Bureau of Entomology, spoke before the Maryland Beekeepers Association at Baltimore on January 6. Dr. J. W. Bulger and Mr. J. E. Eckert of the same Laboratory spoke before a meeting of this Association at Baltimore on February 6.

Dr. A. P. Sturtevant of the Bee Culture Laboratory of the Bureau of Entomology, was one of the speakers at the Short Course for beekeepers given by the Ontario Agricultural College in January, as well as at the Short Course given by Cornell University in the same month, and the Short Course given by Ohio State University in February.

Miss Hilda S. Black, a graduate student of Columbia University, has been given a temporary appointment as Junior Biologist in the Bureau of Entomology of the United States Department of Agriculture for the purpose of working on certain phases of the food value of honey. This work is being done in co-operation with the Bureau of Home Economics.

Horticultural Inspection Notes

Messrs. Forest G. Inman, Oral A. Hardy, Carl H. Spiegelberg and Raymond G. Smith have recently been appointed junior plant quarantine inspectors with the Federal Horticultural Board and are stationed at New York City.

Mr. William Shinn was appointed to the position of junior plant quarantine inspector February 10, with headquarters in Boston, Mass. Before being employed by the Federal Horticultural Board Mr. Shinn was in the inspection service of the State of Oregon.

Dr. Norman Perrine recently returned to Washington from a trip to the Mexican border where he was sent to test out Vacuum fumigation plants installed for the treatment of cotton to prevent the spread of the Pink Boll Worm. He spent several days at El Paso, Texas and Roswell, New Mexico.

Mr. A. H. Greer has been transfered from the Pink Boll Worm eradication work to the inspection service of the Federal Horticultural Board, with headquarters at El Paso, Texas. He takes the place of Mr. Robert B. Lattimore who was transferred to the Pink Boll Worm eradication force.

Shipments of Christmas trees and Christmas greenery from New England in November and December, 1925, were from 12 to 14 per cent larger than the 1924 shipments. A large force of Federal inspectors was necessary to handle the work

which had to be done between November 1 and December 15, inspecting approximately 1,740,000 spruce and balsam trees, ranging in length from two feet to 30 feet, 34,160 bales of spruce boughs, and 6,095 bundles of laurel. This material was moved in 1,033 carload lots, 802 partial carload lots, and 169 auto truck loads. In addition, over 200 lots of wreaths and mixed greens were inspected. The Christmas trees were distributed across the United States in 29 States, outside of New England, extending all the way to California.

Notes on Medical Entomology

According to *Science*, Dr. Joseph Bequaert has been promoted to assistant professor of entomology at the Harvard University School of Public Health.

Junior Entomologist, Raymond G. Shannon, has resigned from the Bureau of Entomology to accept a position with the Argentina government. His work will be the study of the mosquitoes and other disease-carrying insects of Argentina. Negotiations for his appointment were effected through the Rockefeller International Health Board, and the work will be performed in co-operation with that Board. Mr. Shannon, accompanied by his wife, sailed from New York on January 30.

According to *Science*, Dr. F. C. Bishopp, in charge of the work of the Bureau of Entomology on insects affecting live stock, gave a series of talks on the external parasites of domestic animals and poultry at the Iowa State College during the farmers' short course which was held at Ames, February 1 to 6. At the dinner of the Osborn Research Club of the same institution on February 1, he gave an illustrated lecture on "Myiasis and Related Skin Diseases of Man in the United States."

The February number of the Archives of Dermatology and Syphilis contains a report by Dr. J. L. Kirby-Smith, Mr. W. E. Dove and Dr. G. F. White on a type of creeping eruption in man which is quite prevalent in Florida and other coastal states. The causative organism was first supposed to be an insect larva, but the work of the authors proves that the lesion are due to a nematode in the third nstar. This new form is described in the papea as *Agamanematodum migrans*. A treatment which seems to be very effective was developed during the course of the work and is now being employed by numerous physicians in the South.

Pacific Slope Notes

According to the *Experiment Station Record*, Mr. Charles J. Sorenson has been appointed assistant entomologist of the Utah Station.

On January 15, Mr. C. K. Fisher, Bureau of Entomology, addressed 200 persons gathered at the Farm Bureau Center at Arlington, Riverside County, Calif., on the control of bean weevils.

Dr. John A. Comstock, who for the last five years has been director of the Southwest Museum, Los Angeles, Calif., has resigned in order to resume the practice of medicine.

Mr. J. C. Elmore, of the Alhambra, Calif., laboratory, Bureau of Entomology, recently visited the Imperial Valley section of California, finding there damage to lettuce from cutworms and the alfalfa looper.

According to *Science*, Professor Gordon F. Ferris of the Department of Entomology, Stanford University, has returned to the University with a collection of plants and insects from Tres Marias, a group of islands off the west coast of Mexico.

On March 18, Mr. W. E. Dove of the Dallas laboratory of the Bureau of Entomology gave an illustrated lecture before the faculty of Baylor Medical College on creeping diseases of man. The different types of creeping diseases caused by insect larvae were discussed briefly and comparisons drawn between them and the malady known as creeping eruption, upon which Mr. Dove has been carrying on research work during the past year.

The first annual meeting of The American Society of Parasitologists was held in conjunction with the annual meeting of The American Society for the Advancement of Science. The sessions were well attended, and 37 papers were on the program. The authors of all the papers, with one exception, were present. Unfortunately, medical entomology was not very well represented on the program, there being but two papers on this subject, and both of these were given in connection with the Symposium on "Medical Aspects of Parasitology," which was held in conjunction with the section on experimental medicine. These papers were "Recent Developments in the Field of Medical Entomology" by Dr. W. A. Riley, University of Minnesota, and "Species Sanitation in the Control of Malaria" by Dr. Mark F. Boyd of the International Health Board of the Rockefeller Foundation. Dr. C. W. Stiles, U. S. Public Health Service was elected president and Dr. W. W. Cort, Johns Hopkins University, was elected secretary for the ensuing year.

CENTRAL STATES ADVISORY PLANT BOARD

The Central States Advisory Plant Board, consisting of the chief quarantine officials of the twelve north central states, met March 5th and 6th, 1926 at Urbana, Illinois. The principal topics of discussion were:

Importation of Christmas Trees.

Systemic Diseases of Raspberry.

Crown gall inspections, in the light of recent investigations.

Greenhouse inspection.

Consideration of the report of the National Board of Review. According to this report the plant quarantine officers of the four different sections of the United States have formed organizations and appointed members to the National Board of Review, and the National Board is in the process of organization and is ready to function.

Special interest was manifested in the discussion on systemic diseases of raspberry. A cooperative arrangement, suggested by Mr. Geo. M. Darrow, Associate Pomologist, U. S. Department of Agriculture, Washington, D. C., for the testing by him of raspberry plants procured from various raspberry nurseries which have been inspected for systemic diseases by the quarantine officers, was approved by the Board. An effort will be made to furnish Mr. Darrow with 100 raspberry plants of each variety from each of the raspberry plantations inspected for systemic diseases. These will be grown throughout the coming season, be inspected by experts and the results made known to the officers in the states from which the plants come.

The following officers were elected for the ensuing year:

A. G. Ruggles, President, Minnesota.

P. A. Glenn, Secretary, Illinois.

The members of the National Board of Review are:

S. B. Fracker, Wisconsin.

F. N. Wallace, Indiana.